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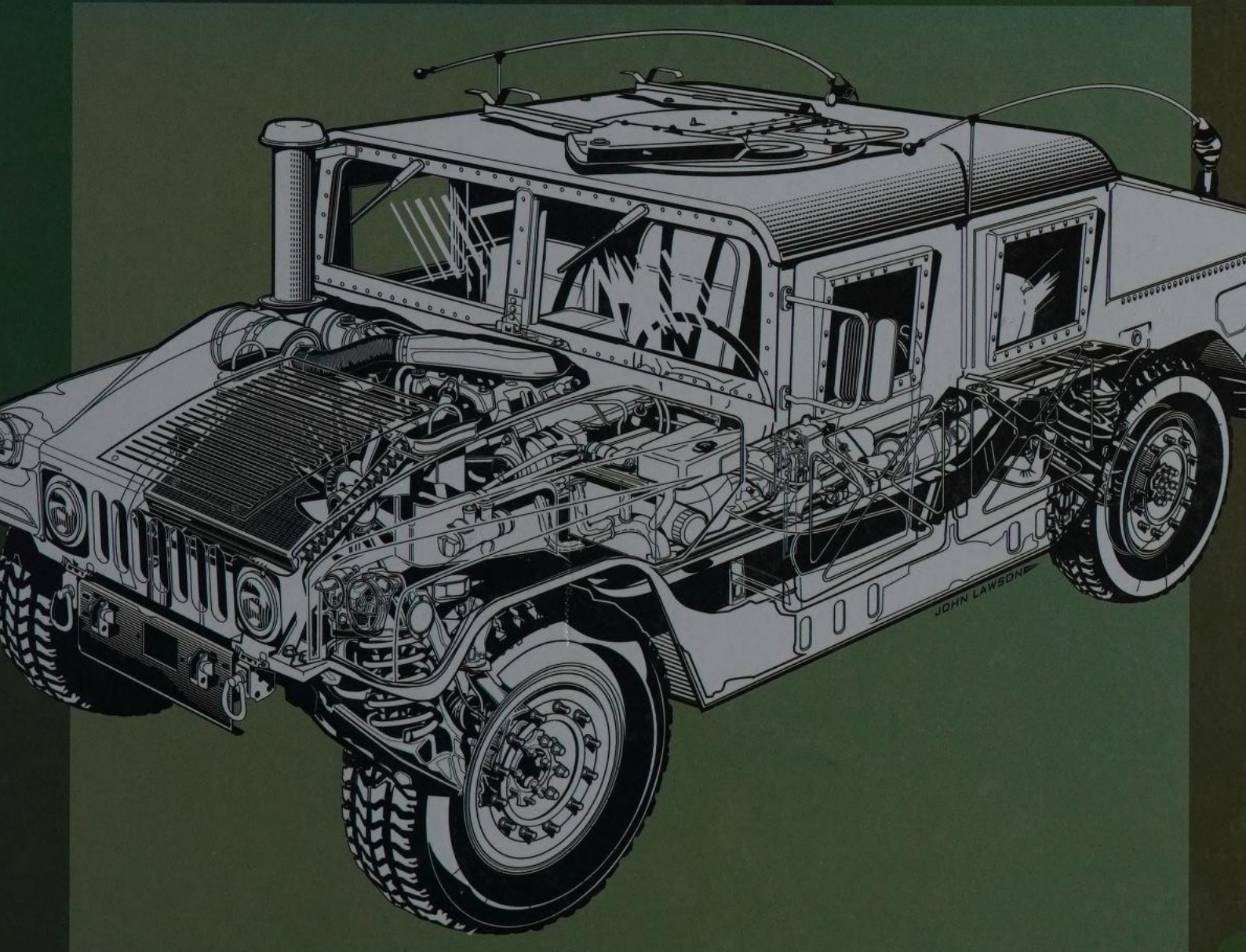
AM GENERAL HUMVEE

1985 onwards (all military variants)

Enthusiasts' Manual



An insight into owning, restoring, servicing and driving the US Army's iconic high-mobility multi-purpose wheeled vehicle (HMMWV)

AM GENERAL HUMVEE

1985 onwards (all military variants)

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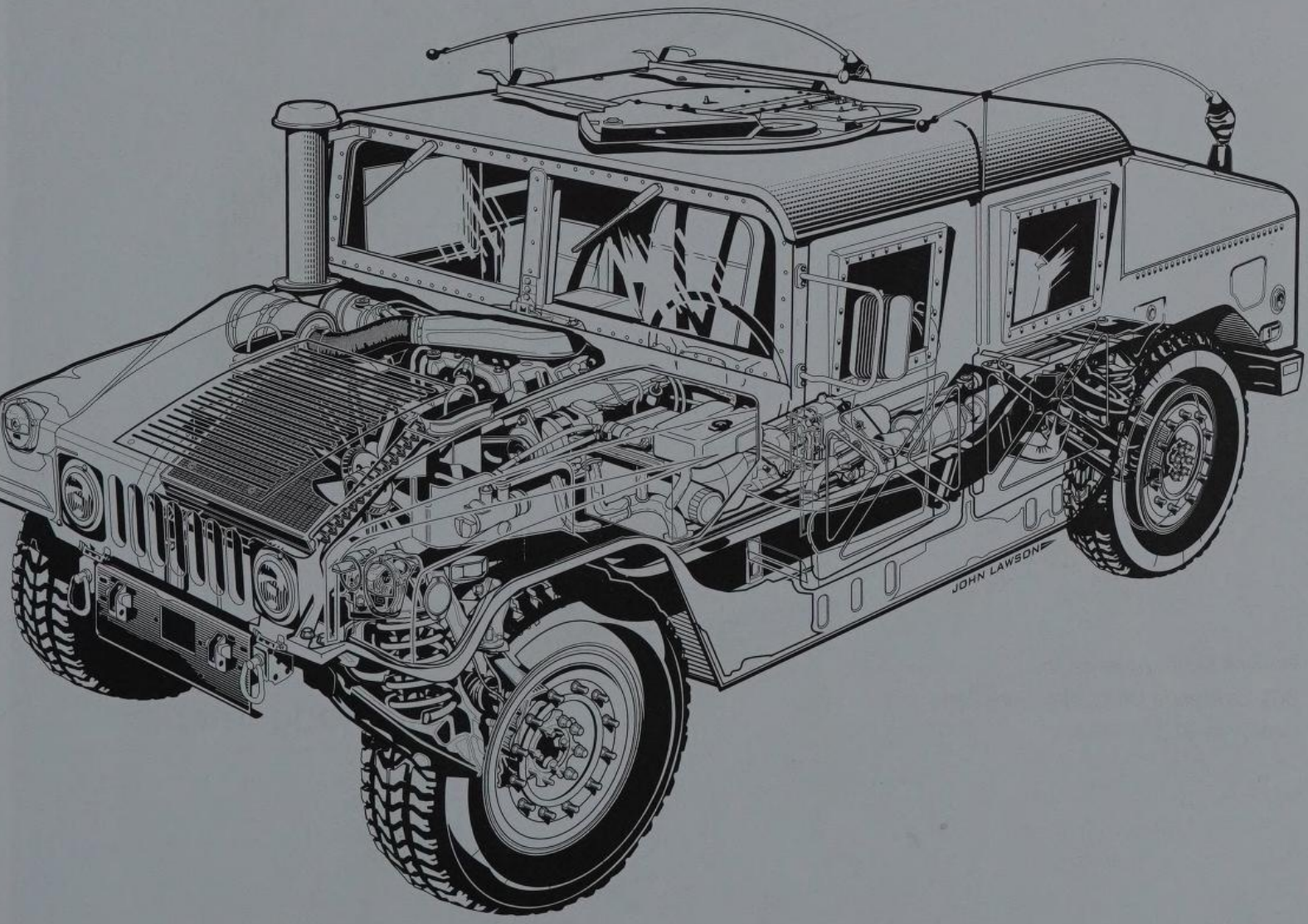
AM GENERAL HUMVEE

985 onwards (all military variants)

Enthusiasts' Manual



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Pat Ware

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(US Department of Defense)

OPPOSITE The cargo/troop carrier, in this case as the M1038 winch-equipped variant, is considered to be the base vehicle of the Humvee family. This example has been set up in the four-door configuration, albeit the doors and the cargo cover are not fitted. *(David Doyle)*

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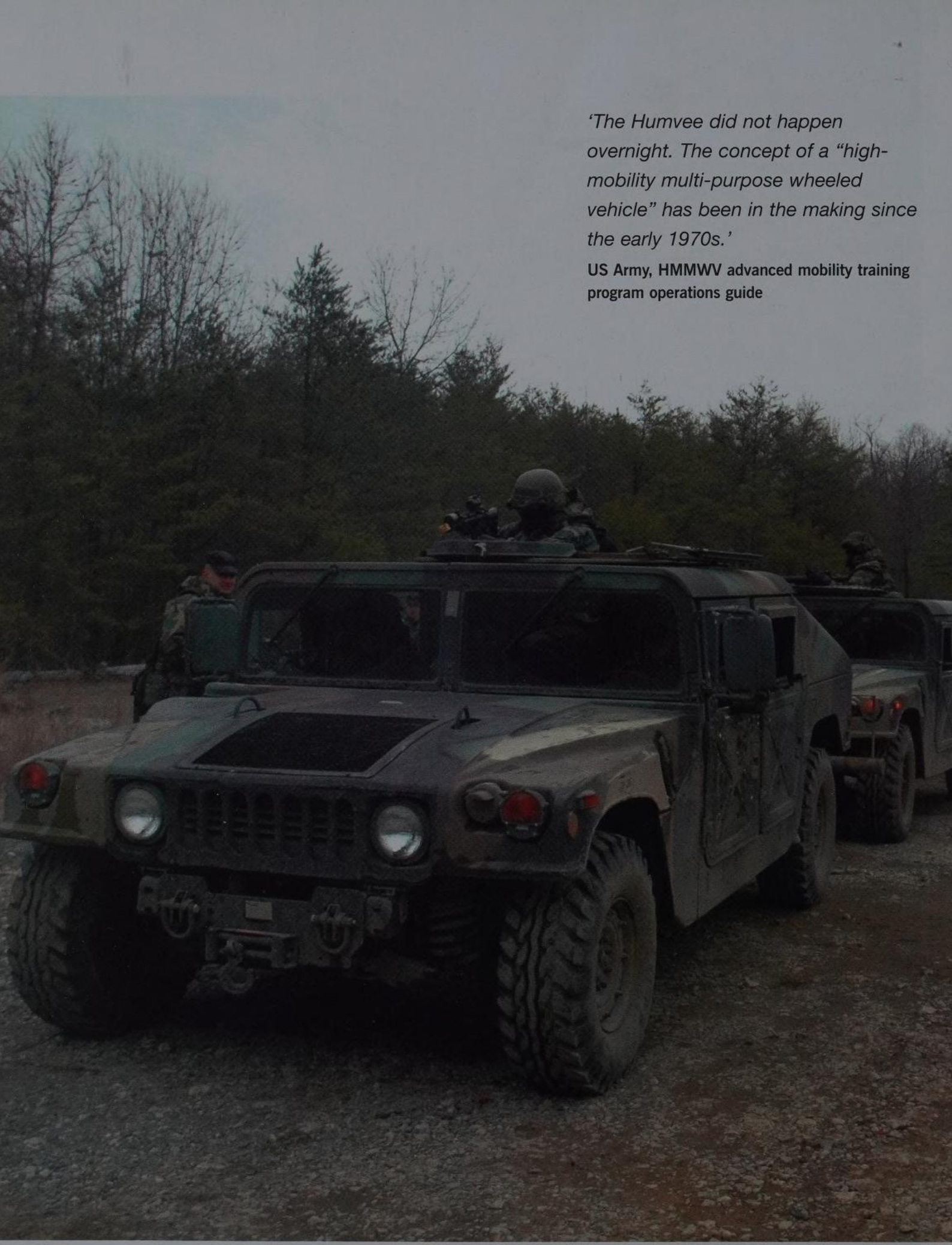


'The Humvee did not happen overnight. The concept of a "high-mobility multi-purpose wheeled vehicle" has been in the making since the early 1970s.'

US Army, HMMWV advanced mobility training program operations guide

Introduction

The Humvee is often described as being a replacement for the ubiquitous Jeep and has even been described as 'a Jeep on steroids'. This is partly true, in so far as there is a connection, albeit tenuous, between the Humvee and the World War Two Jeep. However, if a historic comparison must be made, then it might be more accurate to suggest that the multi-role Humvee is more a replacement for the Dodge WC series... even though the Dodge was long considered obsolete by the time the Humvee was conceived.

In truth, the Humvee was a replacement for a number of vehicles, ranging from the 0.25-ton M151 MUTT ('military utility tactical truck'), which certainly was a logical successor to the Jeep, to the over-ambitious 1.25-ton M561 Gama Goat. However, in order to put the Humvee into its proper context, it is sensible to start with the story of the Jeep.

In 1940, the US Quartermaster Corps issued a requirement for a light field reconnaissance car, and invited more than 130 manufacturers to bid for the development of a pilot model and to manufacture 70 pre-production vehicles. Only three – American Bantam, Willys-Overland and Ford – chose to participate in the programme and, of these, only Bantam produced a prototype within the timescale. Bantam was also the only company to manufacture the required 70 pre-production vehicles.

Each prototype had its advantages and each of the three companies was awarded contracts for 1,500 vehicles, but by the time the vehicle went into production in 1941 as the standardised Jeep, it was being produced only

OPPOSITE US Air Force airmen preparing for a run during convoy training at Fort Dix, New Jersey, March 2007. The lead vehicle is a winch-equipped M1026 armament carrier. *(US Department of Defense)*

BELOW Despite having two wheels clear of the ground, this four-door M998 cargo/troop carrier demonstrates that plenty of traction is still available. *(AM General)*

ABOVE Where it all began! In 1940 the US Quartermaster Corps asked the US motor industry to develop a small four-wheel-drive utility vehicle. American Bantam delivered their prototype for trials in September 1940, and subsequently constructed 70 pre-production versions of what was described as the BRC-60. *(David Doyle)*

by Ford and Willys. Despite having developed the original prototype, and despite having influenced the design of the production vehicle in no small measure, American Bantam was never involved in mass-producing what became the world's most successful military vehicle.

Nevertheless, the standardised Jeep was produced in large numbers, with some 639,245 examples constructed before production ceased in 1945. The vehicle saw service in every theatre of operations during World War Two, and proved to be an enormously adaptable machine that could go almost literally anywhere that a man could walk. Alongside its original role as a cargo and reconnaissance vehicle, the Jeep was adapted for use as a machine-gun mount, anti-tank vehicle, front-line ambulance, radio communications vehicle, signals line-layer, makeshift railway locomotive, and special-forces patrol vehicle. There were experimental lightweight, armoured and half-tracked variants, and Ford also constructed the amphibious GPA using components of the standard Jeep.

In 1940 the Jeep had been a brand new concept in military vehicles. By the end of the war it was unthinkable that any modern army could successfully deploy to the field without a

RIGHT Following the success in trials of the BRC-60, American Bantam constructed 2,642 examples of the improved BRC-40... before being eliminated from future contracts in favour of Ford and Willys-Overland. *(Warehouse Collection)*

ABOVE Ford's contribution to what became known as the Jeep project was the GP. Of the 3,699 examples constructed during 1941, before the 'standardised' Jeep was adopted, 50 were equipped with four-wheel steering in an effort to improve mobility. *(Warehouse Collection)*

LEFT By November 1941 American Bantam was out of the picture. Over the next four years, Ford and Willys-Overland constructed a total of 639,245 'standardised' Jeeps between them; Ford's contribution was 277,896 examples of the GPW, whilst Willys built 361,349 examples of the MB. *(US Signals Corp)*

ABOVE By the end of the 1940s, most European nations had plentiful supplies of American Jeeps. Believing that the original design could be bettered, the French Delahaye company came up with the VLR-D, featuring independent suspension by torsion bar and a dry-sump engine. It was not a success. *(Warehouse Collection)*

ABOVE Similarly believing that the Jeep concept could be improved, between 1952 and 1955 the British Army purchased some 14,000 examples of the Rolls-Royce-engined FV1801 Austin Champ. Advanced features included torsion bar independent suspension, built-in waterproofing, and five forward and reverse speeds. Although more successful than the Delahaye, it was soon replaced by the far simpler Land Rover. *(Warehouse Collection)*

Jeep, or a Jeep-like vehicle, and, although the US Army retained thousands of Jeeps during the immediate post-war years, large numbers were supplied to the armies of the newly liberated European nations.

Inevitably, attempts were made to improve the concept. Whilst the US Army's first post-war Jeep – the M38 or Willys MC – differed little in concept from the original, both France and Britain made attempts to come up with something better, in the form of the Delahaye VLR-D and the FV1801 Austin Champ respectively. Both eschewed the technical simplicity of the original Jeep for a degree of complexity that it was believed would provide a quantum step forward in performance... alas for both, this also proved to be their undoing. The Delahaye was forced to yield to a licence-built copy of the World War Two Jeep; the equally complex Champ succumbed to the simplicity of the Land Rover. And when the US Army finally updated the Jeep concept with the M151, this also proved to be too sophisticated for its own good, suffering handling problems that were never solved.

However, with the passage of time it was, nevertheless, clear that the Jeep and its direct ancestors were no longer adequate for the modern role of soldiering. And it must have been equally clear that many of the technological advances that had been made in automotive engineering since the Jeep appeared in 1941 could offer advantages to the military.

BELOW By the time the Humvee was launched in 1984, technology had caught up with the Army's aspirations, and features such as independent suspension, traction control and electronic engine management systems had become both commonplace and reliable. The photograph shows a line-up of brand new M1152 cargo/troop/shelter carriers at the US Army's Fleet Support Division. *(US Department of Defense)*

'The military version of the Jeep has, for all practical purposes, finally left the field ... the last one was built for the US military in 1985... [it has been replaced] by its much larger, much more complex and much more able successor ... the Humvee.'

***Houston Chronicle*, 20 January 1991**

Chapter One

Development of the Humvee

By the mid-1970s, the lighter end of the US Army's logistical fleet had become something of a compromise. With a mixture of modified civilian vehicles and purpose-built but less-than-satisfactory military machines, there was little coherence or commonality across the range, as well as way too many different vehicles. It was time to take a fresh look at what was actually required.

OPPOSITE Although never conceived as an armoured vehicle, the Humvee has been progressively 'hardened' throughout its 25-year life in response to experience gained in service. This is the M1151 expanded capacity armament carrier, equipped with the so-called 'integrated armour package' (IAP). *(AM General)*

RIGHT Photographed in April 2004, Sergeant First Class Eric Anderson maintains security during an inspection of abandoned buildings in Dibbis, Iraq. The vehicle is the M1114 expanded capacity, up-armoured armament carrier. *(US Department of Defense)*

RIGHT The US Army's first post-war Jeep was the Willys MC – or M38A1 – of 1950. Based on the civilian CJ3A, it featured a 24V electrical system and built-in waterproofing, but otherwise differed little from the wartime MB/GPW. *(Warehouse Collection)*

In the US Army, all of the World War Two Jeeps had probably been disposed of by the mid-1950s. The first replacement, which superseded the oldest and most tired examples of the original, was the M38, or Willys MC, of 1950. This, in turn, gave way to the much-improved M38A1 in 1952. Both were succeeded by the M151 MUTT ('military utility tactical truck'), which first entered service in 1960. Designed by the Ford Motor Company in the early 1950s, the M151 had originally been conceived as a low-cost, almost 'throwaway', machine that would be available in large numbers. Unfortunately, the swing-axle suspension set-up resulted in serious handling problems that were never really resolved, even in the final M151A2 configuration. The Army also operated a pedestrian-controlled half-ton utility load-carrying platform – the M274 'Mechanical Mule' – that was not intended for highway use.

The US Marine Corps had its own vehicle

LEFT In 1952 the Willys MC was joined by the improved MD, or M38A1. The original side-valve Go-Devil engine, which had also been used in the wartime MB, was replaced by the Hurricane, featuring overhead inlet valves. *(Warehouse Collection)*

LEFT Entering production in 1960, the independently sprung M151 was developed by the Ford Motor Company as a replacement for earlier Jeep models. The swing-axle suspension set-up led to handling problems, which, despite the appearance of improved A1 and A2 variants, were never properly resolved. *(Warehouse Collection)*

ABOVE The US Marine Corps' lightweight M422 Mighty Mite of 1960 was developed by American Motors with air-portability in mind. The unconventional design featured aluminium construction, a V4 air-cooled engine and independent suspension using quarter-elliptical springs. *(Warehouse Collection)*

in this weight class in the form of the M422 'Mighty Mite'. Again, it proved to be rather too small for modern warfare, but – at least in this case – its diminutive size was deliberate, since it had been developed especially for delivery by air... and, with its air-cooled engine and aluminium construction, it was every bit as expensive as the M151 was cheap!

Aside from all the technical difficulties, it was becoming clear that the 0.25–0.5 ton payload of these vehicles was not adequate for the well-equipped 20th-century warrior.

Of the larger vehicles, the successful 0.75-ton Dodge WC series of the war years had been superseded by the very similar M37 in 1950, albeit in a reduced number of variants. But, by the mid-1960s, this weight class was also considered inadequate for many roles, and a new payload class of 1.25 tons had been introduced. Experiments were conducted with various types of vehicle, with both 4x4 and 6x6 driveline configurations, and by the end of the 1970s three groups of vehicle had emerged: these were based on the Kaiser

LEFT Introduced in 1967, and rated at 1.25 tons, the Kaiser Jeep M715 was designed to supersede the 0.75-ton class that had originated in World War Two, and was considered an interim replacement for the Dodge M37. *(Warehouse Collection)*

ABOVE Dating from 1973, and forming part of the 'commercial utility cargo vehicle' (CUCV) family, the Dodge M880 1.25-ton 4x4 and 4x2 truck was based on the Chrysler Corporation's commercial W200 pickup truck. It was designed to replace both the M715 and the M37. *(US Department of Defense)*

Jeep M715, the extraordinary M561 Condec 'Gama Goat', and the essentially commercial M880 Dodge 4x4 pickup – the last described as being part of the 'commercial utility cargo vehicle' (CUCV) family. The M151 had serious handling problems, and it would probably be fair to say that the articulated and amphibious 'Gama Goat' was an unmitigated disaster, but in truth none of these vehicles were entirely successful.

BELOW The high-mobility amphibious M561 'Gama Goat' was manufactured by Condec (Consolidated Diesel Electric Corporation), and was a genuine attempt at breaking the mould. Rated at 1.25 tons, and featuring four-wheel steering and a 6x6 or 6x2 driveline, the two components of the vehicle were designed to pitch and roll relative to one another to ensure maximum cross-country ability. Sadly, it was not a success. *(Warehouse Collection)*

This was a situation that could not continue, and in the mid-1970s the US Army had started to look for a suitable vehicle to mount a new tube-launched, optically-tracked wire-guided (TOW) anti-tank missile. The M151 was unsuitable for a number of reasons, and there was a brief flirtation with a so-called combat support vehicle (CSV), specifically developed for the role. However, by 1977 the CSV had been abandoned, since the numbers of vehicles involved made little economic sense; but it may well have been the seed from which the Humvee project grew, because in 1979 the US Army announced a competition for a new and versatile family of vehicles that would be known as the 'high-mobility multi-purpose wheeled vehicle' – better known as the HMMWV, and later as the Humvee – and intended to be sufficiently powerful to carry the levels of equipment required by the modern soldier. A draft specification was issued that set out the basic parameters of the vehicle in terms of outline dimensions and performance, and it was clear that the Humvee was an entirely new type of vehicle.

In service, the Humvee eventually replaced the M151, the M561 'Gama Goat', the M715, including their ambulance variants, the M274 'Mechanical Mule', and large numbers of M880 CUCVs. It was planned that 100,000 existing vehicles of these types in the US Army, Marine Corps and Air Force would be superseded by 50,000 Humvees.

The inevitable paperwork

On 26 January 1979 a Joint Mission Element Need Statement (JMENS) was initiated for the proposed high-mobility multi-purpose wheeled vehicle (HMMWV). The document was signed off by W. Graham Clayton Jr, the Deputy Secretary of Defense, on 8 July 1980, combining the previous requirement for 0.75- and 1.25-ton expanded mobility tactical trucks into a single vehicle type. Alongside a list of some 60 US defence bodies that were circulated with the document, all of them identified by bewildering acronyms, copies were also supplied to Britain, France, Japan and West Germany for information.

Much was being demanded of the vehicle,

and the document listed the following 'mission areas': 'land warfare, including close combat, fire support, ground air defence, and land combat support; air warfare, including close air support, battlefield interdiction, and air warfare support; and naval warfare, including amphibious warfare, and naval warfare support'. The document went on to describe the primary functional objectives, as follows:

- Mobility/agility both on and off the road, consistent with weapons and equipment carried.
- Payload consisting of sufficient capacity in both weight and volume to allow functional teams, crews or operators to deploy as a single unit with weapon systems, equipment or cargo.
- Improved survivability against indirect fire fragmentation for crew, weapon systems, critical vehicle components, other cargo, equipment and ammunition loads.

The vehicle was to be transportable by external lift using what was described as 'the new generation utility helicopter', as well as by medium-lift helicopters, tactical lift aircraft and strategic transport aircraft, whilst at the same time 'striving to reduce aircraft and air sortie requirements'.

The JMENS document granted exception from the normal Defense Systems Acquisition Review Council procedure, and assigned the development process to the US Army on what was described as an 'aggressive schedule'. Just 17 months were allowed between the award of the development contract and so-called 'type classification', which was to include five months of testing. It was hoped that the Humvee would be developed to the point where it could be used to perform 'multiple mission roles by 1983 or earlier'. A total of $11.3 million was required during financial years 1980, 1981 and 1982 in order to meet the proposed development and acquisition schedules, with funding provided by the Army and the Marine Corps from their research, development, testing and evaluation budgets. Finally, there was a projected cost of $2.26 million to acquire a total of 54,000 vehicles in two phases. This figure was compared to a projected price of $2.254 million for the continued acquisition of existing 'unsuitable vehicles' over the same period should the decision go against the development of the Humvee.

These simple sketches, showing alternative configurations for the vehicle, formed part of TACOM's (Tank-Automotive and Armaments Command) 1979 proposal for a new high-mobility multi-purpose wheeled vehicle. *(TACOM)*

A draft specification was released in May 1979, and this was to be followed up by 'Requests for Proposals' (RFP) issued worldwide during 1980. The RFP included the instruction that prototype vehicles should make maximum use of existing technology and off-the-shelf military and commercial components, both to keep the costs under control and for maximum reliability.

The commercial response to the RFP was to form the basis for the selection of 'not less than

two, and not more than three, contractors to enter a competitive programme for the design and fabrication of prototype test vehicles'. The project was being managed by Ronald Wummel of the US Army's Tank-Automotive and Armaments Command (TACOM).

With the first step of the development process under way, a presentation was given to the House Appropriation Committee. Established under Clause 7 of the US Constitution, the committee is in charge of setting specific US government expenditures and carries a great deal of power. The meeting was held at TACOM's Tactical Wheeled Vehicle Management Office in Warren, Michigan, and the presentation covered the scope of the current and planned truck fleets and described the study that had been conducted to determine the numbers of tactical wheeled vehicles required through financial year 1986, as well as to develop a programme to allow transition to the preferred fleet. Having highlighted the deficiencies of the existing fleet, it was explained that the proposed Humvee would provide a single vehicle family to satisfy joint service requirements by selectively replacing existing M151 MUTT and M880 CUCV vehicles, as well as all M274 'Mechanical Mule', M561 'Gama Goat' and M792 'Gama Goat' ambulances. The funding, development and production programmes for the Humvee were described in outline.

In response to a question from one of the committee regarding the possibility of using commercially available vehicles, it was explained that a market analysis had been conducted of existing domestic and foreign vehicles that might satisfy the draft Humvee specification. Foreign vehicles that were reviewed included the German Volkswagen Iltis and Unimog 1300; from Sweden, the Volvo Laplander 4140 and 5300; the British Land Rover forward-control '101' and the Stonefield P3000; the French SUMB MH600BS and Renault-Saviem TR3; as well as the Austrian Pinzgauer 710 series and the smaller Haflinger. Domestic vehicles included the Chrysler expanded mobility truck, the Food Machinery Corporation (FMC) XR-311, American Motors CJ5 Jeep, Dodge Ramcharger, Ford Bronco, GM Blazer and International Harvester Scout.

None were considered to be suitable, and TACOM's response to the committee was to state that 'there are no known vehicles which can satisfy the Humvee role on an as-is basis... but there are indicators that the Humvee requirements can be achieved by various vehicle manufacturers, both domestic and foreign, through modification of existing vehicles or through application of on-going high-mobility vehicle programs.' A total of 61 contractors were said to have requested copies of the specification; eight of these were considered to be 'prime contractors who have either developed a prototype vehicle based on perceived needs and/or developed plans to modify an existing vehicle to meet our requirements'.

Pre-prototypes

As it finally appeared, the Humvee owed much to the experimental FMC XR-311 combat support vehicle that had first appeared in 1969. Although not purchased in quantity by the US Army, the XR-311 proved to be something of a trendsetter; but, as is often the way with defence projects, there was a good deal of time wasted in blind alleys before the right path became clear.

FMC XR-311

Originally developed as a private project by FMC, the XR-311 was constructed around a spaceframe chassis of tubular steel, and was powered by a rear-mounted 5.7-litre Chrysler V8 petrol engine producing 200bhp. It was effectively a fast, militarised version of the powerful dune buggies that raced in the Baja 500, and the machine's low, wide stance, combined with features such as permanent all-wheel drive, limited-slip clutches in both axles, lockable inter-axle differential and oversized radial tyres, provided spectacular off-road performance. At the same time, the maximum speed on the road of 80mph (130kph) was equally impressive for a military utility vehicle.

In 1970, FMC offered two XR-311 prototypes to the US Army's Land Warfare Laboratory for evaluation. A year later, a further ten examples – this time fitted with a smaller 5.2-litre Chrysler V8 engine – were provided to the Army Armor

& Engineer Board. Despite being impressed with the performance of the machine, which was put through something like 200,000 miles (324,000km) of arduous testing, it came at a time when spending on defence was being reined in, and the Army was not in a position to pursue the project further. Nevertheless, FMC went on to produce a third-generation prototype, powered by a slightly down-rated version of the 5.2-litre V8 engine in combination with an automatic transmission. A small number were sold to Israel in 1974, but by 1978 FMC had clearly decided that discretion was the better part of valour, and the manufacturing rights for the XR-311 were sold to AM General.

Much of the technology that was developed during the testing of the XR-311 was carried over into AM General's submission for the XM966 programme, and was subsequently written into the 'Request for Proposals' (RFP) for what became the Humvee.

XM966 programme

In 1977, TACOM announced what was described as the XM966 combat support vehicle programme, calling for a common platform that would be able to perform as a cargo/troop carrier, weapons mount and front-line ambulance, and which could initially be used to replace the M151 in certain roles. AM General put forward a modified version of the XR-311, whilst contributions also came from Teledyne Continental Motors, who submitted the Chrysler-designed Cheetah, and the Chrysler Corporation with their Saluki high-mobility truck. Cadillac Gage also offered a version of their armoured Commando Scout.

All of the contributions were initially powered by petrol engines, but some way into the trials phase TACOM decided that a diesel engine made more sense, since this would allow the US Army to use diesel fuel throughout its tactical vehicle fleet. The manufacturers were asked to reconsider their submissions. AM General and Chrysler adopted a 6.55-litre Canadian-built Deutz air-cooled V8 engine, whilst Teledyne fitted a six-cylinder Volvo unit. All of the vehicles were also fitted with an automatic transmission, in order to reduce driver-training time and maintenance expense and to improve off-road performance.

ABOVE AM General's prototype for the XM966 project was derived from proposals originally developed by FMC (Food Machinery Corporation) for the XR-311. *(AM General)*

XM998 prototype development

The XM966 programme was never successfully concluded because, in 1979, TACOM issued a new specification for what was now being described as a 1.25-ton high-mobility multi-purpose wheeled vehicle (HMMWV), designated initially as the XM998, but eventually to become known as the Humvee. The participating manufacturers were invited to resubmit against the new specification.

Five manufacturers had responded to TACOM's 'Request for Proposals', but only three were contracted to develop prototypes. On 1 July 1981 contracts for the development of 11 prototype vehicles, designated XM998, were awarded to AM General, General Dynamics, and Teledyne Continental. The prototypes were scheduled to be delivered for 'durability and operational testing' during April/May 1982.

By April 1982 the initial phase of testing of the prototypes – now described as 'development testing' – was under way, continuing through to November 1982, by the Army Test and Evaluation Command at Aberdeen Proving Ground in Maryland, and at the Yuma Proving Ground , Arizona. During this stage of the process the vehicles were driven by both civilian and military test drivers, with maintenance crews provided by the manufacturers. At the end of this stage, AM General's prototypes had demonstrated the best performance.

The second phase of the work, the 'operational testing', was carried out between June and September 1982, and was managed

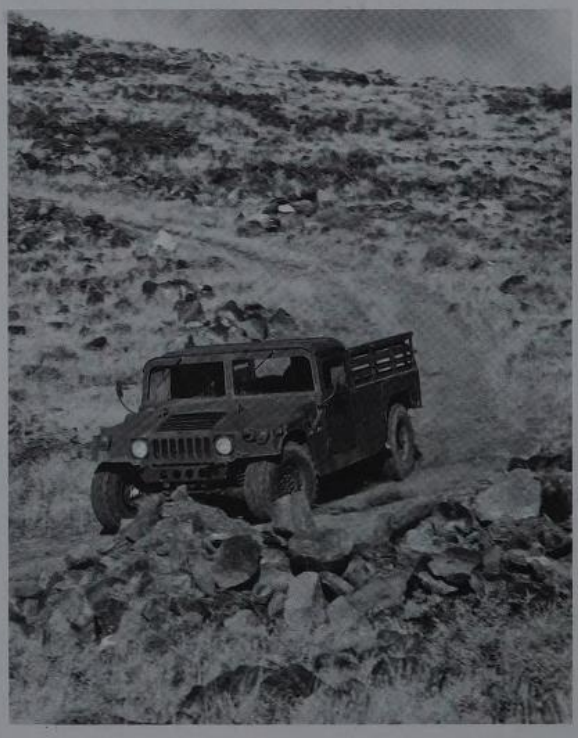
by the Army Operational Test and Evaluation Command at three locations in California – Fort Hunter Liggett in Monterey County, the Marine Corps base at Camp Pendleton in San Diego County, and the Navy Amphibious Base at Coronado, where amphibious landing trials were conducted. The actual work was carried out by the Combat Developments Experimental Command, using normal military maintenance staff – a factor that caused problems for all three of the manufacturers involved.

Phase three of the test programme took place in mid-November 1982 at the Army Engineer Board at Fort Knox, Kentucky, and included rough-terrain handling and deep wading.

By October 1982, the Assistant Secretary of the Army for Research, Development and Acquisition had already approved the use of a multi-year procurement contract. The three companies involved produced their production proposals during November, at the same time indicating any design modifications that were required to correct deficiencies identified during the development and operational testing.

The Army's preliminary evaluations were completed during December 1982 and the first production contract was awarded on 22 March 1983.

RIGHT This is AM General's submission to the XM998 project that superseded the XM966 in 1981. Although the shape and general appearance of the vehicle are close to that of the production version, there are noticeable differences in the radiator grille and in the top-hung windscreen. *(AM General)*



RIGHT Pre-production Humvees were extensively tested in various roles during 1984 before production proper got under way. These vehicles can be identified by the four, rather than three, holes perforating the front cross-member. *(AM General)*

AM General

AM General, which described itself as 'the largest builder of military trucks outside of the Soviet Union', had started work on the project in September 1979, even before the formal TACOM request for proposals had been issued. General manager of the Humvee project was Eugene S. Zembrzuski. His team included Joseph E. Walasinsky, assistant chief manufacturing engineer; Arthur Deeane, chief body engineer, aided by Tim L. Clark and Gene W. Rakoczy; and Charles S. Brinkley and Robert A. Moore of AM General's stamping division.

Implementing what the company described as a 'full development programme', a prototype vehicle test-bed was assembled at the company's own expense and was put through more than 17,000 miles (27,500km) of testing as the design was improved. In response to the formal RFP, the company developed five engineering prototypes using engineering data derived from the test-bed vehicle. Although AM General had initially indicated to TACOM that they would continue to use the Deutz F8L-610 air-cooled diesel engine that had been specified for the XM966, when the first prototype was completed in August 1980 it was powered by a GM Detroit Diesel Allison V8 diesel engine, in conjunction with a GM Allison 727 Turbo Hydra-Matic three-speed automatic transmission with full-time four-wheel drive.

Suspension was by double 'A' arms and coil springs, but where AM General's submission differed most from the other two was in the choice of a backbone chassis that lowered the overall height of the vehicle and allowed easy access and egress due to the lack of a sill panel to step over. The downside was that there was an enormous transmission tunnel that prevented passengers from shifting from one side of the vehicle to the other.

Using techniques learned in the aircraft industry, the aluminium body components were glued together and then riveted for minimum weight combined with maximum strength. The prototypes were very close in appearance to the subsequent production vehicles, but featured a distinctive horizontal grille arrangement with nine narrow slots and round, rather than the later squared-off, headlight apertures. When changes were subsequently made to the engine cover to allow greater front-wheel travel, the number of slots was reduced to seven. Other notable identification features of these early prototypes include a windscreen that was arranged to swing upwards – with some prototypes fitted with four short windscreen wipers – and a blackout driving lamp that was mounted on the engine cover above the left-hand turn indicator.

In December of 1981, AM General started durability testing of its initial five prototypes at the privately owned Nevada Automotive Test Center, near Carson City, where more than 50,000 miles (81,000km) covered in field trials was designed to simulate the projected military durability and operational trials. At the same time, work began on constructing the 11 additional prototypes for the government trials. By the time these trials were over, the vehicles had logged more than 100,000 miles (162,000km), and by January 1985, when all of the trials were completed, AM General's test vehicles had logged a total of 581,567 miles (942,139km) in testing.

Inevitably, problems arose during the trials, including failures in the fuel system, the brakes, the power-steering system, the electrical system, the suspension and shock absorbers, and the tyres – but none was insurmountable. There were also problems with cracking of the chassis and the body and damage to the body mounts. All of the components of the vehicle were also carefully examined to ensure that everything met or exceeded the Army's specification.

By the time AM General submitted its production proposal to the Army in November 1982, the company believed that all of the problems that had arisen during the durability and operational testing had been rectified in the basic design.

LEFT Although the 'modular desert vehicle' had originated with American LaFrance, it subsequently passed to FMC, where it became known as the 'modular military vehicle' (MMV). In this form, it was put forward as a possible contender for the Humvee project. *(Warehouse Collection)*

The other contenders

Of the 61 manufacturers that had originally been contacted back in 1980, just five had expressed a serious interest in the project – American LaFrance, AM General, FMC, General Dynamics Land Systems and Teledyne Continental Motors. Respected US military-vehicle historian Fred Crismon also reported that Adcor Industries had shown an interest, but no further information is available on this.

Fire appliance and truck manufacturer American LaFrance submitted what was described as the 'modular desert vehicle' (MDV Mk1), powered by a five-cylinder Deutz air-cooled diesel engine; this morphed into the 'multi-duty vehicle' (MDV Mk2). The company dropped out when the development engineer involved moved to FWD, taking the project with him. FWD's contribution was described as the 'modular military vehicle' and, although it is said to have performed well, the anticipated production costs were too high and the project did not progress further. FMC had intended to submit their XM911 prototype for the project, but withdrew due to a lack of production facilities.

In the end there were just three serious contenders: AM General, who were the first to complete prototypes, and who eventually went on to win the contract, General Dynamics and Teledyne Continental. Given the tight specification drawn-up and issued by TACOM, it is surprising how differently this was interpreted by the three manufacturers.

General Dynamics

Although work on the General Dynamics prototype was initiated by Chrysler Defense Products Division, in the form of what was now being described as the 'expanded capacity vehicle' (ECV), when Chrysler Defense was

RIGHT The General Dynamics submission to the XM998 project was this Deutz-engined 'expanded capacity vehicle', reportedly using some 75 per cent commercial parts. The prototype is on display at the Heartland Museum of Military Vehicles in Lexington, Nebraska. *(David Doyle)*

BELOW Teledyne Continental's XM998 prototype was powered by an International Harvester V8 diesel engine, and was based on the Cheetah off-road vehicle that the company had acquired from Mobility Technology International. The prototype has survived and is on show at the Veterans Memorial Museum, Huntsville, Alabama. *(David Doyle)*

sold to General Dynamics in 1982 – for a figure rumoured to be $348.5 million – the project changed hands along with the company.

Several different variants were constructed, with both petrol and diesel engines, but the 11 prototypes were powered by the same type of Deutz F8L-610 V8 air-cooled diesel engine that had been considered by AM General. Bob Lusardi of General Dynamics defended the choice of an air-cooled power unit by explaining that some 30–40 per cent of engine failures in a combat situation are caused by problems with the cooling system, and that air-cooled engines are better suited to operating in climatic extremes. Power output of the Deutz was declared at 160bhp from 6,555cc, and the engine was coupled to a Chrysler Torqueflite A727 three-speed automatic transmission with permanent all-wheel drive. Suspension was by conventional 'A' arms and coil springs at the front, with a Dana live axle at the rear 'borrowed from a commercial pickup truck', and also suspended on coil springs.

Contemporary press reports state that the vehicle incorporated 75 per cent commercial parts, and certainly, a decided shortage of development cash meant that the Chrysler vehicle was constructed on a modified version of the conventional ladder-frame chassis of the Dodge D-150 pickup truck. This resulted in both a rather ungainly appearance and, with an overall height that was some 10in (254mm) higher than the Teledyne version, there was some compromise as regards the centre of gravity. The body, which placed three passengers in the front and one in the rear, was constructed from aluminium and featured just two doors.

The ECV was eventually rejected as being unsuitable, but at least one prototype has survived and is on display at the Heartland Museum of Military Vehicles in Lexington, Nebraska (www.heartlandmuseum.com).

Teledyne Continental

The third serious contender was Teledyne Continental Motors, headquartered in Mobile, Alabama. Teledyne's contribution to the project was based on the Cheetah off-road vehicle that Teledyne had acquired from Mobility Technology International. It featured independent variable-rate suspension at all four corners, using double 'A' arms and longitudinal variable-rate torsion bars, and was powered by a new International Harvester Corporation water-cooled V8 diesel engine producing 170bhp from 6,883cc, driving through a GM 475-THM three-speed automatic transmission with part-time four-wheel drive. The engine was carried in a welded steel wrap-around box frame, on which was mounted an aluminium body configured for either two or four doors. Unlike the AM General submission, with its huge transmission hump, the floor was virtually flat, allowing crew to enter from one side of the vehicle and leave from the other.

Weapons carrier, troop/cargo carrier and ambulance versions were constructed but, like the General Dynamics submission, Teledyne's vehicle was also eventually rejected as being unsuitable. A second-generation prototype is on display at the Veterans Memorial Museum, Huntsville, Alabama (www.memorialmuseum.org).

FAR LEFT Pre-production M1025 armament carrier photographed during testing. *(AM General).*

LEFT AM General's Humvee squad carrier variant, seen here in pre-production form, was not adopted by the US Army. The vehicle had a fully enclosed crew and passenger compartment and could transport a fully equipped eight-man infantry unit plus two additional crew members. *(AM General)*

AM General declared winner

In almost every respect, and at every stage of the trials, the AM General prototypes outperformed those of the rival manufacturers. The vehicle was appreciably lighter than the competition and was proved to be both durable and reliable, and the company was awarded the first production contract on 22 March 1983, initially for 2,334 vehicles, with the initial base vehicle identified as the M998 cargo/troop carrier. Winning the contract was based on a combination of the most technically qualified vehicle and the most cost-effective five-year production bid, and this was the first increment of a five-year contract for nearly 55,000 Humvees with a total value of $1.2 billion. The M998 variant was priced at $20,410, with the armament carrier rising to $28,382.

AM General had every reason to be pleased with what it had achieved, and in 1985 AM General's president, Lawrence M. Hyde, told the press that 'together with the Tank-Automotive Command, we have designed and produced a vehicle that will have a profound effect on the Army's ability to quickly move and fight in the most rugged of combat environments. We are extremely proud of the Humvee, and we believe the Army will be equally proud of this great tactical vehicle.'

The company had already allowed US motoring journalists access to the prototypes and to the early production vehicles, and during 1983 and 1984 glowing reports of the 'Army's new super Jeep' appeared in magazines as diverse as *Popular Mechanics*, *Off Road*, *The American Legion Magazine* and *Popular Science*. It would be fair to say that nobody was disappointed!

LEFT Rear view of the distinctive beetle-backed armament carrier; the hatchback can be opened either from the top or the bottom. *(David Doyle)*

'For many years the US Army had been operating a bewildering range of light vehicles. In 1983 this changed with the first delivery of the Humvee... [produced] in five body styles with 15 configurations, namely utility, cargo, ambulance, truck and cargo shelter carrier.'

AM General. M998 sales brochure: November 1990

Chapter Two

The production Humvee

AM General received the first production contract in March 1983, and the company set about establishing a production line during the following year, with a total of 20 or so pre-production vehicles initially constructed for durability testing and evaluation purposes. In early July seven of these vehicles were shipped to the US Army's Aberdeen Proving Ground, with five more going to Yuma. Here, the vehicles were scheduled to undertake six months of 'initial production testing'.

OPPOSITE **The rare M1116 base security/personnel carrier is deployed by the US Air Force for airfield defence. This photograph was taken during a demonstration at McChord Air Force Base, Washington, in July 2007.**
(US Department of Defense)

ABOVE The first Humvee, an M998 cargo/troop carrier, came off the production line on 2 January 1985. The company predicted that, by mid-year, production would reach 65 vehicles a day. *(AM General)*

The first production Humvee, a cargo/troop carrier, rolled off the end of the line on 2 January 1985 and deliveries to the US Army started almost immediately. Production for the first contract continued for five years.

As an intriguing aside, it wasn't just the military that were impressed by the Humvee. In December 1984, the Aluminium Association announced that the Humvee had won its Automotive Aluminium Engineering Design Competition. Speaking for the Association, R.E. Daugherty said that 'designers faced with specifications as demanding as those for the Humvee choose aluminium to meet weight and strength requirements... in the Humvee's case, the design engineers also needed a material that could provide a 15-year body life in the field under the most demanding conditions. The Humvee is indeed a winning design use of aluminium.' Other winners for 1984 included the driveshafts of the Chevrolet Corvette and the whale-tail spoiler of the Pontiac TransAm – putting the Humvee in excellent company!

In February 1985 AM General even fielded a mud-splattered production Humvee in the 'special interest' category at the seventh annual Michiana Auto Show held at the Century Center in South Bend, Indiana.

Political shenanigans

As usual with government work, nothing was plain sailing. Even before the first production Humvee had been completed, the decision to place the production contract had come in for some official criticism. In June 1984 the US General Accounting Office (GAO) completed a more than 12-month review of the development and operational tests that had been conducted on the Humvee and produced a report to the Secretary of Defense suggesting that the 'Army's decision to begin production of the high-mobility multi-purpose wheeled vehicle (HMMWV) was premature'. The publication of the report allowed various newspaper sub-editors free rein, leading to headlines such as 'Bugs make Hummer a humbug', 'Army's Jeep replacement, the Hummer, is a bummer', and 'Hummer is $1 billion out of tune'.

In the view of the GAO, the reliability issues that had arisen during the operational tests meant that additional testing should have been carried out before 'large sums of production dollars were committed'. Furthermore, the GAO believed that the 'design of the HMMWV was not stable, as evidenced by the numerous design changes being made to the pre-production vehicles to correct hardware problems experienced during prototype testing'.

The GAO stated that whilst the Humvee 'did display improved performance capabilities compared with the vehicles it is replacing in areas such as speed, mobility and cargo capacity... it fell short by a wide margin of achieving the reliability requirements'. In support of this, it was pointed out that during the operational testing phase of the trials, the vehicle attained an average of just 82 mean miles (133km) between 'unscheduled maintenance actions', against a requirement of 320 miles (518km). The corresponding figure for the mean distance travelled between 'mission failures' – meaning that the failure was sufficiently serious that the vehicle was unable to continue its mission without repair – was 367 miles (595km) against a requirement of 1,300 miles (2,106km).

Programme officials attributed the large differences in results between the test phases to differences in test conditions and the types of driving to which the vehicles were subjected. During the development trials, the Humvees were driven by experienced test drivers and maintained by skilled mechanics with access to fully equipped workshop facilities. However, during the subsequent operational testing the vehicles were maintained by regular army mechanics working under field conditions and the vehicle speeds were not controlled

in the same way. According to the Humvee development team, the poor showing during these trials was attributable to the excessive speeds at which the vehicles were driven over cross-country routes, rather than to inherent serious defects in the design of the vehicle itself.

Unconvinced, the GAO pointed out that this claim could neither be supported nor refuted since 'the vehicles had no metering devices to record driving speeds'. The GAO maintained its claim that the 'design of the HMMWV was not stable... and that the Army was not in a good position to properly evaluate the HMMWV's design stability', nor, for that matter, 'approve the use of a multi-year contract'. The GAO believed that the fact that the Army approved the vehicle for production 'in the face of poor reliability results in operational testing' indicated a breakdown in the acquisition process.

AM General defended its position by pointing out that the company had made 'extensive changes to its Humvee design as a result of experience gained during both the test phases of the trials'.

The GAO recommended that the Army initiate a follow-on operational testing programme in an environment that would closely simulate actual field conditions, and the Department of Defense agreed. Nevertheless, Senator William V. Roth attempted, unsuccessfully, to have the Senate block funds for the production of the Humvee until reliability was proven in additional trials. The Senate voted 51–38 to reject Senator Roth's proposal, but a new round of testing was planned to begin in July 1984 and to run for seven months, with the intention of assessing the vehicle's ability to meet the contract specifications.

Further testing

In early July 1984, AM General shipped 12 Humvees – consisting of five weapons carriers and seven utility vehicles – to the US Army proving grounds at Yuma and Aberdeen for what was being described as 'initial production testing'. Part of this testing process was intended to determine the ease of maintenance, including, for example, changing a wheel and tyre or a fan belt in the field.

In early August there was considerable consternation when a propeller shaft broke whilst a test vehicle was being driven at 71.5mph (116kph), a speed that AM General considered to be excessive. Further testing was halted whilst the failure was investigated. Five Humvees were deliberately driven by AM General engineers at speeds of 77–80mph (125–130kph) in an attempt to induce the failure. Three of the five vehicles suffered the same failure, which was identified as being due to harmonic vibration of the shaft at speed. The Army and AM General replaced all of the propeller shafts on the test vehicles, and when testing resumed in mid-August the vehicle's speed was limited to the contract specification of 65mph (105kph) and there were no further problems. AM General and the Army subsequently agreed that all Humvees would be fitted with a two-part propeller shaft, with a centre bearing race, at no extra cost to the government. Three modified test vehicles were subsequently driven a total of 15,000 miles (24,300km) at Aberdeen Proving Ground without incident.

In September 1984 five pre-production Humvees were delivered to Fort Hunter Liggett for the 'follow-on production test and evaluation', with each vehicle scheduled to be driven 5,000 miles (8,100km) over a six-week period. The work was completed by 1 November, with an accumulated total of 30,867 miles (50,005km) for the five vehicles. The third phase of the follow-on testing took place at the US Marine Corps' Camp Pendleton and at the Naval Amphibious Base at Coronado, where two vehicles completed 1,200 miles (1,944km) of beach mobility testing, and at Fort Knox, Kentucky, where three Humvees accumulated 3,000 miles (4,860km) of mobility testing on

ABOVE The initial Humvee programme comprised 16 variants, retrospectively described as the M998A0 series. The photograph shows the beetle-backed M1025 armament carrier (foreground) and the M998 cargo/troop carrier configured with two doors and a high cover over the cargo area. *(AM General)*

ABOVE A convoy of Humvees proceeds through the Norwegian countryside during 'Operation Cold Winter 87', a NATO-sponsored military exercise. The lead vehicle is the M966 TOW missile carrier; the second vehicle is the M1036, identical in every way save for the inclusion of a front-mounted winch. *(US Department of Defense)*

what was described as 'European type terrain'. The final rounds of durability testing ended at the Yuma Proving Ground on 29 November, with the two vehicles involved logging a total of 40,014 miles (64,822km), and on 14 December when all four vehicles completed a requirement of 20,000 miles (32,400km) each.

Finally, in March 1985 a cargo/troop carrier was driven a distance of 10,000 miles (16,200km) in temperatures as low as -50°F (-45°C) at the Army's Cold Region Test Center at Fort Greely, Alaska.

Modifications to production vehicles

As a result of issues that arose during the testing programme, a considerable number of modifications were made to the design of the vehicle. Alongside the problems with the broken driveshafts, it was found, for example, that there was excessive internal wear of the tyres caused by the magnesium alloy run-flat inserts, and that the brakes allowed the ingress of mud and dirt during wading operations. Stories of the problems that arose during testing started to leak out into the public domain, and there was a fair amount of negative reporting in the US media, with Jim Brady of the *New York Post* going so far as to call the Humvee 'a lemon'.

The press also latched on to the fact that, when fully loaded, the Humvee was too heavy to be lifted by a Black Hawk helicopter. Major Don Maple, speaking for the US Army, explained that this had not been a basic requirement for the vehicle at the time that the contract was awarded but had been added afterwards as a 'test requirement' ... albeit one that 'it had never been possible to meet'.

Nevertheless, AM General and the Army were said to be working through the problems as they arose, and by March 1985 the *New York Times* was quoting Major Maple and 'an Army spokesman' as stating that 'all of the problems had been resolved'. A full list of the modifications that were made includes:

- Changing the axle ratio
- Changing the ratio of the torque converter
- Modifying the cooling fan
- Modifying the design of the braking system
- Modifying the engine drive system for the engine accessories
- Modifying the exhaust system
- Modifying the suspension and shock absorbers
- Modifying the tyres
- Redesigning the air-cleaner inlet
- Redesigning the front driveshafts
- Redesigning the propeller shafts
- Redesigning the roof-hatch cover
- Relocating the engine and radiator
- Shortening the chassis

Of course, this meant that the first production Humvees were significantly different from those that had been tested during the prototype stage, but the vehicle was much improved by the process.

Production models

Initially rated for a military payload of 1.25 tons, the first generation of Humvees, introduced in 1984, was generically described as the M998 series, after the base model M998 cargo-troop carrier. All of the M998 variants were powered by a GM Detroit-Diesel Allison V8 four-stroke water-cooled diesel engine of 6,227cc, producing 150bhp, and driving through a three-speed automatic transmission. When the A1 update was introduced in 1993 it became common for the first series to be referred to as the M998A0.

Mention of the first significant upgrade came in June 1989, when an addendum to the original JMENS document laid down the operational characteristics of the proposed 'heavy Humvee variant' (HHV) vehicle, as follows:

- Availability of 'arctic' kit
- Fording capability to 30in (762mm) without preparation
- Individual weapons mounts for the crew
- Installation of 200Ah generator with umbilical cable to the junction box in the cargo area
- Installation of blackout lighting
- Installation of certified cargo tie-downs
- Minimum payload capability of 4,200–4,500lb (1,909–2,045kg)
- Single-channel radio capability
- Towing capability of 4,200lb (1,909kg)
- Use of run-flat tyres

The HHV, which is also considered to form part of the first series, first appeared in an AM General sales presentation dated June 1989, although photographs show that the vehicle in question was derived from the original prototype, since it still sported the horizontal grille arrangement. At the time it was still described as the XM1097, and it was suggested that the modifications were available to customers across the entire M998 range. Production started in September 1992, and the HHV formed the basis of the M998A1 upgrade that followed in 1993. Initially, no changes were made to the engine and transmission, but late production examples were fitted with a four-speed electronically controlled transmission and an improved NP242 transfer case. Other modifications included improved front seats.

Although there was no actual M998A2 model, the third generation was nevertheless introduced in 1995, and was described as the M998A2 series. There were 11 variants, of which the M1097A2 was considered as the base model. The major modification was a change to a new 6,555cc naturally aspirated V8 diesel engine producing 160bhp, and incorporating a redesigned emissions system, including a catalytic converter, designed to meet the 1995 US EPA (Environmental Protection Agency) standards. All A2 variants were fitted with the four-speed electronically controlled transmission and the new transfer case. Other changes included hubs that were designed to accept the central tyre-inflation system (CTIS), a redesigned exhaust system, improved air cleaner, sun visors and a dual-voltage 14V/28V alternator.

Consisting of just five variants, the so-called 'expanded capability Humvees' (ECH), also introduced in 1995, were based on the M1097A2 chassis series, with the payload increased to 2.4 tons. The 6,555cc engine was retained, as was the transfer case of the A2 series, but the engine was now fitted with a turbocharger, increasing power output to 190bhp.

Introduced in the summer of 2005, the fifth, and final, Humvee generation is described as 'the M1100 series reliability-enhanced vehicle', and consists of just three basic variants, with the payload upped to 2.6 tons, and with the vehicle specifically adapted to withstand the harsh conditions in south-west Asia. The biggest improvement is that the M1100 series is described as being 'armour ready' and, as well as incorporating some basic armour – the so-called 'A kit' – is designed to allow easy installation (and removal, when not required) of the factory 'integrated armour package' (IAP) 'B kit' armour. Although the engine and transmission are identical to those fitted to the expanded capability vehicles, major modifications include new three-piece chassis rails and cross-members, geared fan drive, new coolant pack and fan shroud, rear differential cooler, new power-steering pump, new shock absorbers, new 'A' arm bushes, increased brake capacity with quick-change pads, redesigned steering requiring less driver effort, new 24-bolt wheels, re-engineered hubs and a new parking brake.

Variants

For the original M998 series, which went into production in 1984, AM General produced 16 factory variants. These remained in production until 1994, with the M1097 heavy Humvee variant (HHV) joining the line-up in 1991. The upgraded HHV formed the basis of the 'A1' upgrade that followed in 1993 and, by this time, the number of variants had been reduced to 11, with a further reduction to nine when the 'A2' upgrade appeared in 1995. Four types of expanded capability Humvee (ECH) were produced in 1995/96, based on the M1097A2 chassis. Finally, with the introduction of the 'enhanced reliability' upgrade – now based on the M1113 ECH – in 2008, the number of factory variants was reduced again, this time to just four. See Table 1, page 29.

TABLE 1: FACTORY HUMVEE VARIANTS

For the original M998 and M998A1 series, separate 'M' numbers were assigned to winch-equipped vehicles; this practice was discontinued when the A2 series was introduced in 1995 leading to some simplification of the range of variants, although the numbering sequence remains confused.

Designation	Date	Engine	Transmission	Description
Original M998 HMMWV series – sometimes referred to as M998A0				
M966	1984	6,227cc, 150bhp, V8 diesel	3F1Rx2 auto	Truck, utility, TOW missile carrier, basic armour, 1.25 ton, 4x4
M996*	1984	6,227cc, 150bhp, V8 diesel	3F1Rx2 auto	Truck, mini-ambulance, 2-litter, basic armour, 4x4
M997	1984	6,227cc, 150bhp, V8 diesel	3F1Rx2 auto	Truck, maxi-ambulance, 4-litter, basic armour, 4x4
M998	1984	6,227cc, 150bhp, V8 diesel	3F1Rx2 auto	Truck, utility, cargo/troop carrier, 1.25 ton, 4x4
M1025	1984	6,227cc, 150bhp, V8 diesel	3F1Rx2 auto	Truck, utility, armament carrier, basic armour, 1.25 ton, 4x4
M1026	1984	6,227cc, 150bhp, V8 diesel	3F1Rx2 auto	Truck, utility, armament carrier, basic armour, 1.25 ton, 4x4, with winch
M1035	1984	6,227cc, 150bhp, V8 diesel	3F1Rx2 auto	Truck, ambulance, 2-litter, soft-top, 4x4
M1036	1984	6,227cc, 150bhp, V8 diesel	3F1Rx2 auto	Truck, utility, TOW missile carrier, basic armour, 1.25 ton, 4x4, with winch
M1037	1984	6,227cc, 150bhp, V8 diesel	3F1Rx2 auto	Truck, utility, S250/S788 shelter carrier, 4x4
M1038	1984	6,227cc, 150bhp, V8 diesel	3F1Rx2 auto	Truck, utility, cargo/troop carrier, 1.25 ton, 4x4, with winch
M1042	1984	6,227cc, 150bhp, V8 diesel	3F1Rx2 auto	Truck, utility, S250/S788 shelter carrier, 4x4, with winch
M1043	1984	6,227cc, 150bhp, V8 diesel	3F1Rx2 auto	Truck, utility, armament carrier, supplemental armour, 1.25 ton, 4x4
M1044	1984	6,227cc, 150bhp, V8 diesel	3F1Rx2 auto	Truck, utility, armament carrier, supplemental armour, 1.25 ton, 4x4, with winch
M1045	1984	6,227cc, 150bhp, V8 diesel	3F1Rx2 auto	Truck, utility, TOW missile carrier, supplemental armour, 1.25 ton, 4x4
M1046	1984	6,227cc, 150bhp, V8 diesel	3F1Rx2 auto	Truck, utility, TOW missile carrier, supplemental armour, 1.25 ton, 4x4, with winch
M1069	1989	6,227cc, 150bhp, V8 diesel	3F1Rx2 auto	Truck-tractor, prime mover for M119 105mm light gun
M1097 heavy HMMWV variant (HHV)				
M1097	1992	6,227cc, 150bhp, V8 diesel	3F1Rx2 auto	Truck, utility, heavy variant, cargo/troop carrier/prime mover, up-armoured, 2.25 ton, 4x4
M1097A1	1993	6,227cc, 150bhp, V8 diesel	3F1Rx2 auto	Truck, utility, heavy variant, cargo/troop/shelter carrier/prime mover, 2.25 ton, 4x4
M998A1 HMMWV series, based on M1097 and M1097A1 chassis				
M966A1	1993	6,227cc, 150bhp, V8 diesel	3F1Rx2 auto	Truck, utility, TOW missile carrier, basic armour, 1.25 ton, 4x4
M996A1*	1993	6,227cc, 150bhp, V8 diesel	3F1Rx2 auto	Truck, mini-ambulance, 2-litter, basic armour, 4x4
M997A1	1993	6,227cc, 150bhp, V8 diesel	3F1Rx2 auto	Truck, maxi-ambulance, 4-litter, basic armour, 4x4
M998A1	1993	6,227cc, 150bhp, V8 diesel	3F1Rx2 auto	Truck, utility, cargo/troop carrier, 1.25 ton, 4x4
M1025A1	1993	6,227cc, 150bhp, V8 diesel	3F1Rx2 auto	Truck, utility, armament carrier, basic armour, 1.25 ton, 4x4
M1026A1	1993	6,227cc, 150bhp, V8 diesel	3F1Rx2 auto	Truck, utility, armament carrier, basic armour, 1.25 ton, 4x4, with winch
M1035A1	1993	6,227cc, 150bhp, V8 diesel	3F1Rx2 auto	Truck, ambulance, 2-litter, soft-top, 4x4
M1038A1	1993	6,227cc, 150bhp, V8 diesel	3F1Rx2 auto	Truck, utility, cargo/troop carrier, 1.25 ton, 4x4, with winch
M1043A1	1993	6,227cc, 150bhp, V8 diesel	3F1Rx2 auto	Truck, utility, armament carrier, supplemental armour, 1.25 ton, 4x4
M1044A1	1993	6,227cc, 150bhp, V8 diesel	3F1Rx2 auto	Truck, utility, armament carrier, supplemental armour, 1.25 ton, 4x4, with winch
M1045A1	1993	6,227cc, 150bhp, V8 diesel	3F1Rx2 auto	Truck, utility, TOW missile carrier, supplemental armour, 1.25 ton, 4x4
M1046A1	1993	6,227cc, 150bhp, V8 diesel	3F1Rx2 auto	Truck, utility, TOW missile carrier, supplemental armour, 1.25 ton, 4x4, with winch

Designation	Date	Engine	Transmission	Description
M998A2 series				
M997A2	1995	6,555cc, 160bhp, V8 diesel	4F1Rx2 auto	Truck, ambulance, heavy variant, 4-litter, basic armour, 4x4
M1025A2	1995	6,555cc, 160bhp, V8 diesel	4F1Rx2 auto	Truck, utility, heavy variant, TOW missile/armament carrier, basic armour, 2.25 ton, 4x4
M1035A2	1995	6,555cc, 160bhp, V8 diesel	4F1Rx2 auto	Truck, ambulance, 2-litter, soft-top, 4x4
M1043A2	1995	6,555cc, 160bhp, V8 diesel	4F1Rx2 auto	Truck, utility, heavy variant, armament carrier, supplemental armour, 2.25 ton, 4x4
M1045A2	1995	6,555cc, 160bhp, V8 diesel	4F1Rx2 auto	Truck, utility, heavy variant, TOW missile carrier, supplemental armour, 2.25 ton, 4x4
M1097A2	1995	6,555cc, 160bhp, V8 diesel	4F1Rx2 auto	Truck, utility, heavy variant, cargo/troop/shelter carrier/prime mover, 2.25 ton, 4x4
M1109**	1995	6,555cc, 160bhp, V8 diesel	4F1Rx2 auto	Truck, utility, heavy variant, armament carrier, up-armoured, 2.4 ton, 4x4
M1121	1995	6,555cc, 160bhp, V8 diesel	4F1Rx2 auto	Truck, utility, TOW missile carrier, supplemental armour, 2.25 ton, 4x4
M1123	1995	6,555cc, 160bhp, V8 diesel	4F1Rx2 auto	Truck, utility, heavy variant, cargo/troop carrier, 2.25 ton, 4x4
M1124	1996	6,555cc, 160bhp, V8 diesel	4F1Rx2 auto	Truck, utility, heavy variant, cargo/troop carrier, 2.25 ton, 4x4, RHD
Expanded capability HMMWV (ECH), based on M1097A2 chassis				
M1113	1995	6,555cc, 190bhp, V8 turbo-diesel	4F1Rx2 auto	Truck, utility, expanded capacity, cargo/troop/shelter carrier, 2.4 ton, 4x4
M1114	1996	6,555cc, 190bhp, V8 turbo-diesel	4F1Rx2 auto	Truck, utility, expanded capacity, armament carrier, up-armoured, 2.4 ton, 4x4
M1115	1996	6,555cc, 190bhp, V8 turbo-diesel	4F1Rx2 auto	Truck, utility, expanded capacity, TOW missile carrier, up-armoured, 2.4 ton, 4x4
M1116	1996	6,555cc, 190bhp, V8 turbo-diesel	4F1Rx2 auto	Truck, utility, expanded capacity, base security/personnel carrier, up-armoured, 2.4 ton, 4x4
M1145	1997	6,555cc, 190bhp, V8 turbo-diesel	4F1Rx2 auto	Truck, utility, expanded capacity, forward air control, up-armoured, 2.4 ton, 4x4
M1100 series reliability-enhanced vehicles, based on M1113 chassis				
M1151	2005	6,555cc, 190bhp, V8 turbo-diesel	4F1Rx2 auto	Truck, utility, expanded capacity, armament carrier, IAP-ready, 2.6 ton, 4x4
M1151A1	2009	6,555cc, 190bhp, V8 turbo-diesel	4F1Rx2 auto	Truck, utility, expanded capacity, armament carrier, IAP-ready, 2.6 ton, 4x4
M1152	2005	6,555cc, 190bhp, V8 turbo-diesel	4F1Rx2 auto	Truck, utility, expanded capacity, cargo/troop/shelter carrier, IAP-ready, 2.6 ton, 4x4
M1152A1	2009	6,555cc, 190bhp, V8 turbo-diesel	4F1Rx2 auto	Truck, utility, expanded capacity, cargo/troop/shelter carrier, IAP-ready, 2.6 ton, 4x4
M1165	2006	6,555cc, 190bhp, V8 turbo-diesel	4F1Rx2 auto	Truck, utility, expanded capacity, command and control/general purpose vehicle, IAP-ready, 2.6 ton, 4x4
M1165	2009	6,555cc, 190bhp, V8 turbo-diesel	4F1Rx2 auto	Truck, utility, expanded capacity, special-operations vehicle, IAP-ready, 2.6 ton, 4x4
M1167	2008	6,555cc, 190bhp, V8 turbo-diesel	4F1Rx2 auto	Truck, utility, expanded capacity, TOW missile ITAS carrier, IAP-ready, 2.6 ton, 4x4
M1167A1	2009	6,555cc, 190bhp, V8 turbo-diesel	4F1Rx2 auto	Truck, utility, expanded capacity, TOW missile ITAS carrier, IAP-ready, 2.6 ton, 4x4
Recapitalization (RECAP) programme – modernised expanded capacity vehicles (MECV) Phase 1				
M1025R1	2004	6,555cc, 160bhp, V8 diesel	4F1Rx2 auto	Conversion of M998/M998A1, M1025/A1, M1026/A1, M1037, M1038/A1 and M1097/A1 to M1025A2 configuration
M1097R1	2004	6,555cc, 160bhp, V8 diesel	4F1Rx2 auto	Conversion of M998/M998A1, M1025A1, M1026A1, M1037, M1038A1 and M1097A1 to M1025A2 configuration
M1151R1	2010	6,555cc, 190bhp, V8 turbo-diesel	4F1Rx2 auto	Conversion of M1114 variants to M1151A1 configuration
RECAP Phase 2, which would have upgraded M1151, M1152, M1165 and M1167 vehicles, was cancelled on 23 January 2012.				

* The M996 and M996A1 ambulances were specified, but never actually put into series production.

** Designated XM1109 UA-HHV (up-armoured heavy Humvee) during development.

ABOVE An M1097 heavy Humvee variant (HHV), in the two-door cargo/troop carrier role, shows what it can do in loose sand. *(AM General)*

BELOW Corporal Josh Parrish photographed at the wheel of an M998 cargo/troop carrier. The photograph was taken during 'Exercise North Fuji Artillery Relocation 09-03' at Camp Hansen, Okinawa. Note the M1037 shelter carrier behind. *(Corporal John Chretien; US Department of Defense)*

ABOVE 8 December 2003: US soldiers in an M998 cargo/troop carrier move out to search for former regime loyalists, foreign fighters and illegal weapons in Pir Ahmad, Iraq. The vehicle retains its Northern European camouflage scheme. *(US Department of Defense)*

Cargo/troop carrier

M998, A1; M1038, A1; M1097, A1, A2; M1113; M1123A2; and M1152, A1

Considered to be the 'base' model of the Humvee family, the cargo/troop carrier is designed for carrying equipment, materials and personnel; conversion to various specific roles can be effected in the field by installing different kits, including a two-seater pickup truck, crew-cab pickup truck and troop carrier with longitudinal bench seats in the rear. A weapons mount can be installed.

The total payload for the original M998 variant, including a two-man crew, is 2,500lb (1,136kg); for the M1097 heavy variant the payload was increased to 4,400lb (2,000kg); and for the M1113 the payload was increased again, to 5,100lb (2,318kg). When fitted with the 'troop seat kit', the vehicle is capable of transporting a two-man crew and eight passengers. When the M1037 and M1042 discrete shelter-carrier variants were discontinued this role was allocated to the M1152 and M1152A1, with the description being amended to 'cargo/troop/shelter carrier'; the artillery prime-mover role was allocated to the M1097. To cope with the increased payload, the M1097 and M1113 variants have

LEFT M1113 expanded capability Humvee (ECH) cargo/troop/shelter carrier being attached to a CH-47 Chinook helicopter at Fort Pickett, Virginia. *(Sergeant Andrew H. Owen; US Department of Defense)*

ABOVE Introduced in 2005, the M1152 is described as an 'expanded capacity enhanced IAP armour-ready cargo/troop carrier'. It can carry eight passengers or a 3,340–5,100lb (1,518–2,318kg) payload. Air conditioning equipment is fitted as standard, and optional 'frag' kits are available. *(AM General)*

a reinforced frame, heavy-duty rear springs and shock absorbers, reinforced control arms, heavy-duty tyres and wheels and a lower ratio gear in the transfer case.

The M1038 and M1038A1 are both equipped with a Warn 6,000lb (2,727kg) electric winch as standard; for A2 and later models the winch was specified as an option. There is a choice of soft tops, covering either the front seats only, or the front and rear seats, as well as a choice of high- or low-profile covers for the cargo area. The plastic-coated doors are removable, and a winterisation kit can be fitted. The M1152A1 is up-armoured, and will also accept the factory IAP armour-ready kits, which can be fitted by the vehicle crew in the field.

The M1123A2 variant was intended for the US Marine Corps.

TOW missile carrier

M966, A1; M1025A2; M1036; M1045, A1, A2; M1046, A1; M1115; and M1167, A1

The TOW missile carrier is designed to mount a Raytheon tube-launched, optically tracked, wire-guided (TOW) anti-tank missile system, with the launch equipment carried on the cab roof of the four-door slant-back body. The rear panel is dual-hinged, and can be opened from the top in the style of a conventional hatchback, or from the bottom. The A2 variants were also required to double as armament carriers.

The weapon system is able to traverse 300° either side of the vehicle centreline, and has a maximum elevation of 20° and a maximum depression of -10°; the shape of the rear body is designed to minimise the possibility of damage to the vehicle from missile exhaust gases. The missile is guided to the target by the operator using a cross-hairs sight and joystick control, and the standard high-explosive anti-tank

BELOW The M966 and M1036 variants, the latter differing only by virtue of its winch, are equipped to carry the Raytheon tube-launched, optically tracked, wire-guided (TOW) anti-tank missile system. The launch equipment is carried on the cab roof of the four-door slant-back body. *(US Department of Defense)*

ABOVE M1045A2 of the Danish Army. Also equipped with the TOW missile launcher, the flat-panelled doors indicate that this variant carries the supplemental armour. *(Carl Schulze)*

(HEAT) shaped-charge warhead can destroy a tank or armoured vehicle at a range of 4,100yd (3,750m); the mount can also be used to fire a BLAAM (bunkers, light armour, and masonry) warhead for use against fortified structures. On the M1167 variant, an improved target acquisition system is used (TOW ITAS). When not in use the launch and operating equipment, together with up to six reload missiles, is stowed in the cargo area. The gunner is provided with a small, height-adjustable platform to stand on between the two front seats.

M966 and M1036 variants have a hard roof and what is described by the US Army as 'basic armour' – but which has been cynically described by some as 'psychological armour' – with Kevlar-reinforced doors and anti-spall polycarbonate glazing. The M1045 and M1046 variants have supplemental armour; M1115 and M1167 are up-armoured, and the latter will also accept the factory IAP armour-ready kits. M1036 and M1046 variants, including the corresponding A1 versions, are winch-equipped as standard; for later models the winch was specified as an option.

The M1045 and M1046 models, and the A1 versions, were intended for the US Marine Corps.

Armament carrier

M1025, A1, A2; M1026, A1; M1043, A1, A2; M1044, A1, M1109; M1114; and M1151, A1

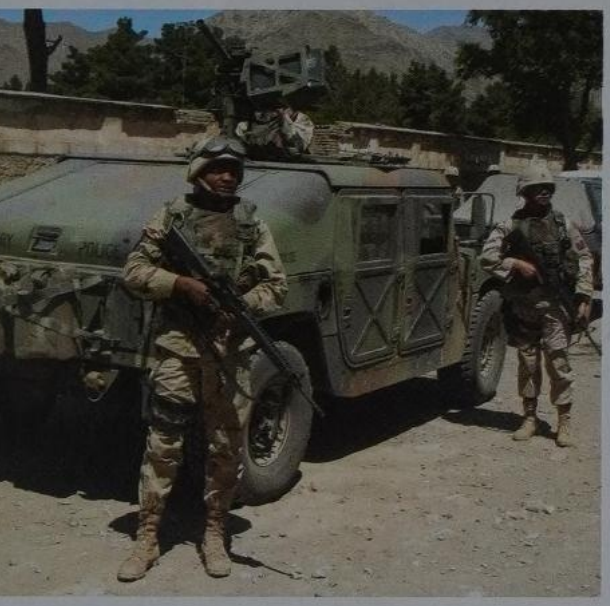
Similar in appearance to the slant-back TOW missile carrier – although the M1114 can be identified by the grilles set into the left side of the slat-back – the armament carrier (sometimes described as a weapons carrier) is designed to mount a range of weapons using an appropriate pedestal and pintle, with full 360° coverage from a 32in (813mm) diameter roof hip ring; the hip ring has a bi-fold circular cover. The A2 variants were also required to double as armament carriers.

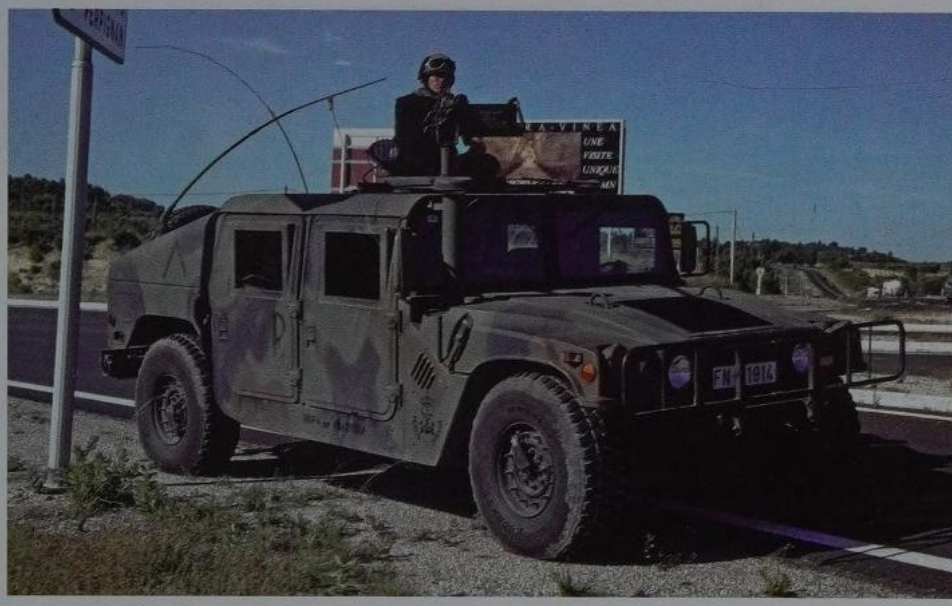
The pintle is designed to accept an M2HB (nicknamed 'Ma Deuce') 0.50in heavy machine gun, M240 (FN MAG 58) or M60 7.62mm general-purpose machine gun, or a Mk 19-3 (modification 3) 40mm automatic grenade launcher. A passive night sight can be attached to any of the weapons. As with the TOW missile carrier, the gunner is provided with a platform to stand on between the two front seats.

M1025 and M1026 variants have 'basic armour' protection; M1043 and M1044 have supplemental armour; M1109, M1114 and M1151 variants are up-armoured, with the latter also designed to accept the factory IAP armour-ready kits. M1026 and M1044, including the M1044A1, are winch-equipped as standard; for later models, the winch was specified as an option.

The M1043 and M1044 variants, including the A1 and A2 versions, were intended for the US Marine Corps.

LEFT The lead vehicle is an M1026 armament carrier of the Luxembourg Army, whilst the second vehicle in the convoy is an M966 TOW missile carrier. *(Carl Schulze)*





ABOVE **Assigned to the US Army's military police, this M1025 armament carrier shows the distinctive appearance of the Kevlar-lined doors used on vehicles described as having 'basic armour'.** *(US Department of Defense)*

ABOVE RIGHT **M1044A1, winch-equipped armament carrier of the Spanish Marines photographed during 'Exercise Eole 1998'.** *(Carl Schule)*

RIGHT **Factory-fresh armoured M1114 – the 'expanded capacity, up-armoured armament carrier'. Note the distinctive extended snout of vehicles that are equipped with the turbocharged Optimizer 6500 engine.** *(AM General)*

LEFT **The M1151 is also described as an 'expanded capacity armament carrier', but in this case is IAP armour-ready. The vehicle is fitted with windscreen-deflector, under-body and sill (rocker panel) armour and energy-absorbing seats.** *(AM General)*

LEFT M997 maxi-ambulance with basic armour. The box-bodied ambulance can accommodate a combination of four stretcher patients or eight seated, and the clearance inside the rear body provides sufficient headroom to allow medical attendants to stand. Note the factory brush guard. *(David Doyle)*

Mini-ambulance

M966, A1

The M966 and M966A1 mini-ambulance was never actually put into series production and the type was deleted from the standard offering in 1994.

Maxi-ambulance

M997, A1, A2

Fitted with a larger, container-style body with basic armour that is proof against ballistic fragments and spent rounds, the M997 ambulance is able to accommodate a combination of four stretcher patients or eight seated, and the high-topped body provides sufficient headroom to allow medical attendants to stand. The rear body, which is separated from the driving compartment by a partition, includes full heating and air-conditioning facilities, as well as NBC (nuclear, biological, chemical) filtration, and there is a separate generator for the additional equipment.

The ambulance body, which is cut away to maintain the departure angle, extends the length of the vehicle by 22in (559mm) at the rear.

BELOW The Marine Corps' M1035 soft-top ambulance (left) is effectively a specialised version of the basic cargo/troop carrier, and is designed to accommodate a two-man crew and a combination of two stretchers or three seated patients. Contrast the height of the M1035 with the standard M997 ambulance alongside. *(US Department of Defense)*

Soft-top ambulance

M1035, A1, A2

Used exclusively by the US Marine Corps, the M1035 is a soft-topped field ambulance designed to accommodate a two-man crew and a combination of two stretchers or three seated patients, with the stretchers stacked one above the other.

LEFT Rear view of the box-bodied M997 ambulance showing how the extended body is cut away at the rear to improve the departure angle. The same body was also offered as the basis of a C3I (command, control, communications, intelligence) vehicle. *(AM General)*

It is effectively a specialised version of the basic cargo/troop carrier, and the body is fitted with four doors and a soft top that covers both the front seats and the rear area. There is a fuel-burning heater, and the vehicle has full NBC protection using a gas-particulate filter unit (GPFU).

Base security/personnel carrier

M1116

Based on the M1097A2 chassis, and exclusive to the Security Forces Squadrons of the US Air Force, the up-armoured M1116 carries a roof-mounted armoured turret.

The manually operated turret provides a full 360° traverse, and can be used to mount an M2 0.50in heavy machine gun, M60 7.62mm machine gun, Mk19 grenade launcher, or an M82A1 Barrett 0.50in special application scoped rifle (SASR), the latter intended to be used to neutralise cluster bombs. The four-door body incorporates a large cargo area at the rear with a square-backed cover, and provides accommodation for a crew of four men, including the gun operator, as well as their personal equipment, weapons and ammunition etc. A heavy-duty heating and ventilation system is also installed.

Shelter carrier

M1037, and M1042

The M1037 and winch-equipped M1042 variants are designed to carry an S250 or S788 standard EMI-hardened (*ie* protected against electro-magnetic interference) integrated command post shelter (SICPS). The six-sided shelter is of aluminium construction, and is secured in the rear of the vehicle by means of

ABOVE Here's how a Humvee looks after a vehicle-borne IED (improvised explosive device) strike. The photograph was taken in Baghdad during 'Operation Iraqi Freedom' in 2005. *(Specialist Preston E. Cheeks; US Department of Defense)*

RIGHT M1037 shelter carrier with soft doors. The vehicle is designed to carry an S250 or S788 standard EMI (electro-magnetic interference) hardened integrated command post shelter. Note the high-level exhaust outlet and air intake stack pipe. *(US Department of Defense)*

LEFT The M1037 shelter carrier was also used as the basis for the Avenger air-defence vehicle. A large electrically operated turret fitted into the load bed carried a pair of missile launch assemblies, each of which held four FIM-92 Stinger ground-to-air missiles. The cab roof was reinforced to provide a working platform. *(US Department of Defense)*

special brackets; shelter carrier variants are also fitted with a special design of tailgate and heavy-duty airlift bumpers. The vehicle is fitted with heavy-duty suspension, and is provided with a 100Ah alternator as standard.

The early version of the shelter carrier (M1037) was also used as the basis for the Avenger air-defence vehicle, mounting an electrically operated turret that carried a pair of missile launch assemblies, each of which held four Stinger ground-to-air missiles.

Artillery prime mover

M1069

Configured as a two-seater vehicle with a large cargo area, the M1069 is designed to tow the M102 or M119 105mm light howitzer and to provide transport for the gun crew. An artillery bustle rack is fitted above the crew compartment

ABOVE AND RIGHT Overhead and frontal views of an Avenger air-defence vehicle at the US Space and Rocket Center at Huntsville, Alabama. Although deployed to Iraq during 'Operation Desert Storm' in 1991, a lack of targets meant that the weapon was not fired in anger. *(David Doyle)*

RIGHT The M1069 two-door artillery prime mover is designed to tow the US Army's M102 or M119 105mm light howitzer, and to provide transport for the gun crew. *(AM General)*

to store a camouflage net, used to conceal the howitzer when the vehicle was stationary; ammunition storage racks are installed in the cargo bed. Heavy-duty springs are installed and the towing pintle is specially reinforced.

Together with its gun, the M1069 can be under-slung beneath a CH-57 Chinook transport helicopter.

When the dual-purpose M1097 was introduced, the M1069 was discontinued.

Command and control/general-purpose vehicle

M1165, A1

Based on the expanded capacity M1113, the M1165 is an armoured command and control and general-purpose vehicle designed for a variety of missions, including the command and control and armed patrol roles; it is available with an optional weapons mount and rotating turret, and includes air-conditioning equipment. Intended for a crew of four men, the M1165 is also available as a special operations vehicle.

The vehicle is supplied as standard with under-body and rocker panel (sill) armour, lower windscreen deflector armour and energy-absorbing seats. Additional armour is available in two kits: the 'A' kit can be factory-installed, whilst the 'B' kit provides additional ballistic and mine protection. Field-installable anti-fragmentation kits are also available to provide more protection to the sides, doors and wheel wells, etc.

BELOW Typical of the expanded capacity up-armoured variants, the IAP-ready M1165 is described as a command and control/general purpose vehicle. It can also be equipped for the special operations role, as well as being available with a weapons mount and turret. *(AM General)*

Other factory variants

Although the major variants are described previously, and are listed in Table 1, pages 28-29, this is not the whole picture. It was always intended that the Humvee would be able to provide a versatile platform that could be adapted for a wide variety of other logistics roles, and this has proved to be the case. The conflicts in Iraq and Afghanistan have spawned a particularly interesting array of 'specials' and, whilst by no means comprehensive, Table 5, page 108, lists many of the roles for which the vehicle has been modified for use by the US Army, US Air Force and US Marine Corps, often mounting specialised weapons or electronic signals equipment.

AM General has also produced a number of experimental 'specials' to further demonstrate the capabilities of the design.

A company press release dated 21 February 1985 described a remote electric-drive turret, mounting an M242 25mm Hughes chain gun that could be fitted to the Humvee. It was claimed that shock loadings generated by the gun were distributed throughout the vehicle frame without damaging the body.

An armoured squad carrier was developed and tested at the National Training Center at Fort Irwin, California, with a fully enclosed crew and passenger compartment that could transport a fully equipped eight-man infantry unit plus two crew members. A ring-mounted weapons station allowed the vehicle to carry a 40mm grenade launcher, M60 7.62mm machine gun, or M2 0.50in machine gun.

There was also a so-called 'downlink TOW missile carrier' that allowed TOW missiles to be fired and controlled by the gunner using an indirect sighting unit featuring a remote video display unit and remote fire-control mechanism. The Stinger missile carrier, which was adopted by the US Army, provided a method of storing and transporting the surface-to-air Stinger missile system and its two-man crew. The vehicle, which includes mountings for communications systems, is able to transport as many as eight Stinger missiles, or two Stingers and six Redeye missiles.

Later possible adaptations proposed by AM General included a light recovery vehicle (wrecker), Mistral and Starburst missile carriers, a field maintenance vehicle and a 106mm recoilless rifle mount.

Other nations, of course, also have their own adaptations: the Spanish, for example, have a special police variant, whilst the Polish Army have a whole array of specialised versions.

BELOW M998 cargo/ troop carrier modified to carry an M40A2 106mm recoilless anti-tank rifle. Produced at Watervliet Arsenal, the weapon dates from the early 1950s and was deployed in both the Korean and Vietnam Wars. In US service, it was replaced by the BGM-71 TOW anti-tank missile system, although it remains in production in India and Iran. *(AM General)*

Right-hand-drive Humvee

The first right-hand-drive Humvee, based on the M998A2 chassis and identified as the M1124, was introduced in February 1996 with a view to securing sales to the Australian Defence Force.

The sales pitch was not successful, but in October 2012 AM General exhibited a right-hand-drive Humvee based on the chassis of the M1097A2 expanded reliability vehicle (ECV) at the 2012 Association of the US Army Annual Meeting and Exposition at the Walter E. Washington Convention Center, Washington. AM General stated that it was hoping to expand sales into those 70 or so countries that drive on the left-hand side of the road, with the emphasis on India, Pakistan and South-East Asia.

Although most components are common to both right- and left-hand-drive machines, the company was keen to point out that the new vehicle, which had been roughly 18 months in development, and required an investment of some $10 million engineering a fully integrated drive system, was more than just a conversion.

LEFT Based on the M998 or M1026, the special forces ground mobility vehicle (GMV) – often described as the DumVee (desert Humvee) – was produced by the US Special Operations Command (SOC). There were four variants, for use by the US Rangers, Special Operations Command, Naval Special Warfare Command and the Marine Corps. *(US Department of Defense)*

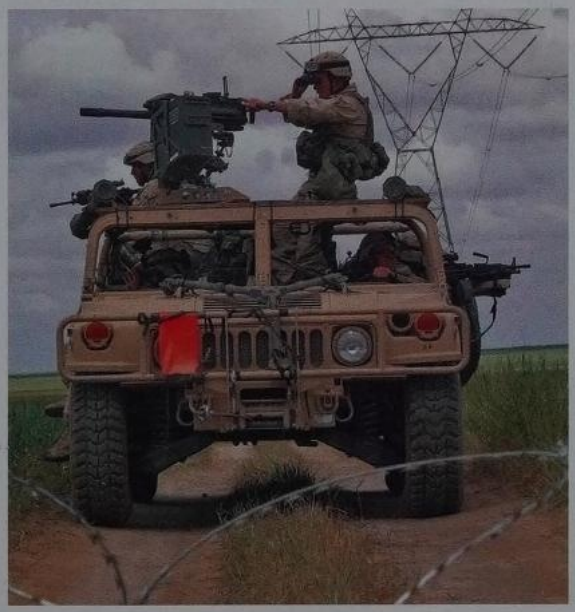
Non-factory variants

The ground mobility vehicle (GMV) or DumVee ('desert Humvee') produced by the US Special Operations Command (SOC) is particularly interesting as an example of a non-factory-produced variant.

Four different GMV variants were produced – GMV-R was intended for use by the US Rangers, GMV-S by the Special Operations Command, GMV-N by the Naval Special Warfare Command and GMV-M by the Marine Corps. The intention was to provide 'special forces' with a platform that was capable of infiltrating and operating in low- or mid-intensity conflicts over varied terrain, whilst also providing the ability to travel unassisted over long distances. Work began in about 1990, and initial vehicles were based on the M998 and M1026 chassis types, with some of these vehicles seeing combat during the First Gulf War in 1991 and in Somalia in 1992–93.

During 1998 Letterkenny Army Depot started to produce kits that allowed standard Humvees to be converted to GMV configuration, and from about 2003 production was ramped up to around 24 vehicles a week. There were subsequent upgrades and improvements, notably to the suspension, but demand tailed off from 2009 as the US Army started to look into a more capable replacement for the Humvee.

LEFT Ground mobility vehicle showing the under-body and sill (rocker) armour. Note the smoke launchers on the corners of the cab roof and the armoured front door; at the rear, the Kevlar-reinforced doors of the basic armour package have been retained. *(Sergeant Keith D. Henning; US Department of Defense)*



LEFT Bristling with weapons, including the Mk19 40mm automatic grenade launcher on the cab roof, the GMV-R is designed for use by the US Rangers. Some of these vehicles were deployed during the first Gulf War in 1991 and in Somalia in 1992–93; the design started to fall from favour in about 2009. *(US Department of Defense)*

ABOVE Produced by Rock Island Arsenal, the US Marine Corps' 'shop equipment contact maintenance and repair' truck carries basic spare parts, tools and equipment sufficient to permit roadside repairs. *(US Department of Defense)*

The US Marine Corps' 'shop equipment contact maintenance and repair' (SECM) truck was another non-factory variant. Manufactured by Rock Island Arsenal, and based on the M1097A2 or M1113, the SECM mounts an enclosed rigid-sided rear body with roll-up shutters that is used to carry tools, welding and cutting equipment and repair parts. The interior is racked out for storage, and a roof rack is often installed over the cab.

Fire-fighting variant

AM General had proposed a fire-fighting variant back in 1989, but nothing appears to have come of it.

However, four years later, in 1993, the Roscommon Equipment Center, in co-operation with Michigan's Forest Fire Experiment Station, published an evaluation of a Humvee chassis that had been modified for use as a 'wild-land' fire-fighting appliance. Based on a military M998, and developed by the REC themselves, the vehicle incorporated pumping and fire-fighting equipment, a foam generator and hose reels, together with a flexibly mounted 300 US gallon (248 Imperial gallon, 1,130 litre) water tank installed in the rear compartment. The cab was of the two-door configuration, using Kevlar doors and a steel roof panel.

It was suggested that surplus military Humvees should be available through the Federal Excess Personal Property programme from about 1998, and that converted Humvees would provide an exceptional lightweight, manoeuvrable off-highway fire-fighter in rural areas.

LEFT AM General developed this fire-fighting variant in 1989, but it was not adopted by the US Army. Years later, the Roscommon Equipment Center, in co-operation with Michigan's Forest Fire Experiment Station, modified a surplus M998 to produce a lightweight off-road fire-fighting appliance for rural areas. *(AM General)*

Armoured protection

The Humvee was never designed as an armoured vehicle and, even though experience in the field has shown that this would have been desirable, the original chassis lacked sufficient power to accommodate the increased weight of armour. Some variants of the original M998, M998A1 and M998A2 series were described as offering 'basic armour' protection, whilst those intended for the US Marine Corps were said to offer 'supplemental armour'; but by no stretch of the imagination could either of these levels of protection be described as being 'bullet-proof'. As a reaction to the lack of proper protection, makeshift armour was often added in the field, in various configurations, taking an inevitable toll on the suspension and driveline components.

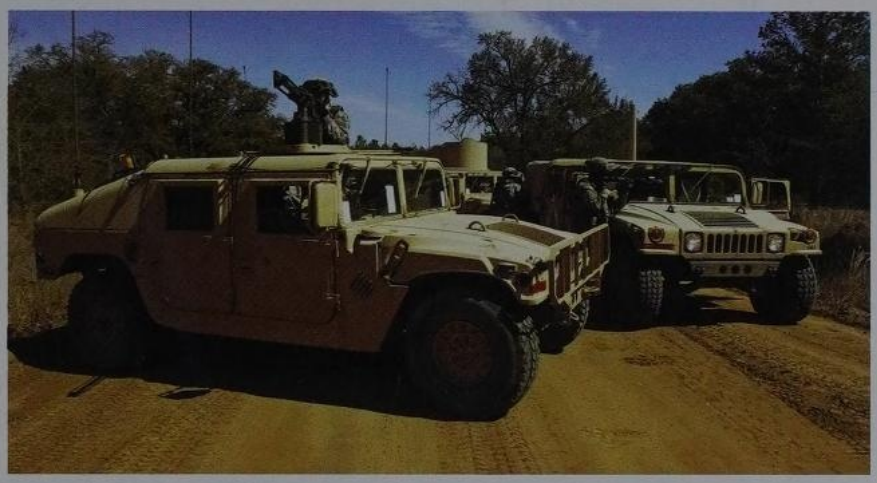
The so-called 'basic armour' comprises a 2in (51mm) thick polycarbonate windscreen and rigid doors of Kevlar composite armour with polycarbonate sliding windows. This level of protection is sufficient to stop ballistic fragments weighing up to 17 grains (0.038oz, 1.1g). Vehicles offering 'supplemental armour' are additionally protected by thin armoured-steel external door linings, designed to stop ballistic fragments weighing up to 44 grains (0.10oz, 2.85g).

In mid-1989 AM General announced that they had developed a 7.62mm *appliqué* armour protection kit that could be bolted to the base armament-carrier vehicle of the M998 series. The kit consisted of internal and external protective panels designed to protect both the crew and the automotive components, together with ballistic glazing material, sufficient to defeat a 7.62mm NATO M80 round with an impact velocity of 2,750ft/sec (850m/sec). It was said that the kit would be available for international sale from 1990.

However, it wasn't until the introduction of the expanded capability M1113 in 1995 that the opportunity was taken to incorporate 'proper' levels of armoured protection using components developed by O'Gara-Hess & Eisenhardt.

Described as being 'up-armoured' (UAH, or 'up-armoured Humvee'), the first vehicle to be treated in this way was the M1109 armament carrier. The vehicle incorporates integrated steel, aluminium and composite armour, and is able to provide full protection from 7.62mm armour-piercing rounds fired from a minimum range of 100yd (91m), as well as air-burst fragments from 155mm artillery rounds. Under-body panels are also used to protect the crew from 12lb (5.4kg) mine blast, and there is a forward-facing armoured gun shield. 'Up-armoured' protection is also provided on the M1114, M1115 and M1145 variants.

The final iteration of the armoured Humvee involves the IAP kit available for the M1100 series reliability-enhanced vehicles, which



ABOVE US Army soldiers from 2nd Battalion, 6th Base Support Battalion, 2nd Brigade Combat Team, 3rd Infantry Division, pull security over the hoods of Humvees after discovering a suspected improvised explosive device during a training exercise. The lead vehicle is an M1025 armament carrier. *(US Department of Defense)*

BELOW In 1989 AM General modified an early prototype or pre-production M1025 armament carrier to provide protection against 7.62mm rounds; the same modification was also available for the M966 TOW missile carrier. The vehicle was offered for sale, with availability said to be 1990, but was not adopted by the US Army. *(AM General)*

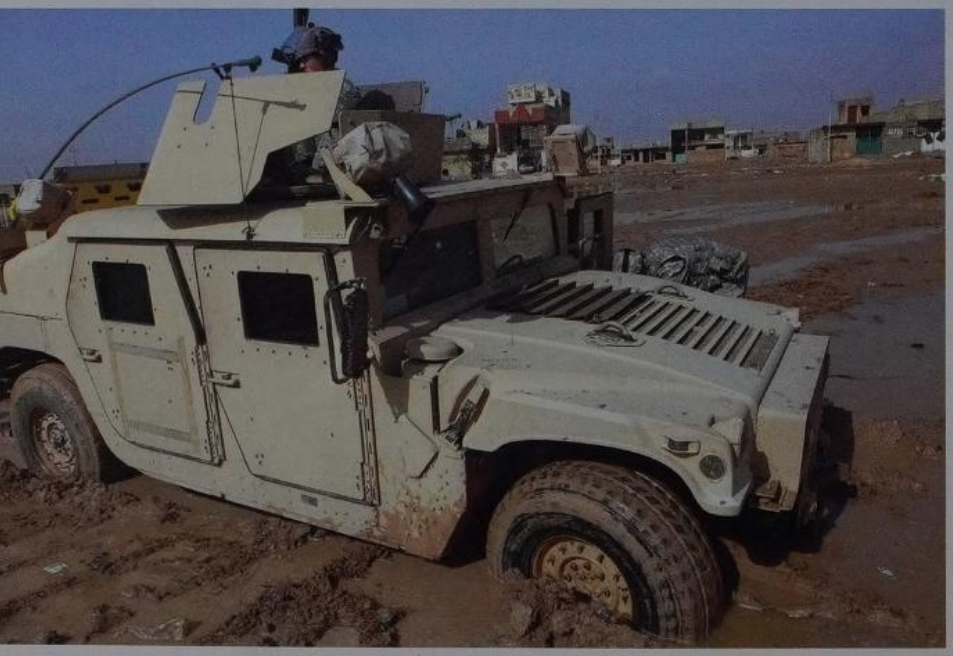
ABOVE M1043 armament carrier with supplemental armour consisting of armoured-steel external door linings, designed to stop ballistic fragments weighing up to 44 grains (0.10oz, 2.85g). The vehicles are attached to a US Army Mobile Security Detachment and were photographed during training at Miramar Naval Air Station, California, in 2007. *(US Department of Defense)*

BELOW M1109 heavy variant up-armoured armament carrier, the first Humvee to provide any real degree of armoured protection. In the photograph, US Army Private First Class Shaughn Ford from HHC, 506th Brigade Troops Battalion, 101st Division, provides security after the vehicle got bogged down in mud during a convoy patrol in the Zafaraniyah District of Iraq. *(US Department of Defense)*

BELOW RIGHT Iraqi Army soldiers await orders for a convoy before setting out for a city council meeting in Baghdad, Iraq, in January 2007. The vehicle is a winch-equipped M1114 armament carrier fitted with fragmentation kit 1 and the gunner shield and gunner protection kits. *(Staff Sergeant Antoine T. Robinson; US Department of Defense)*

ABOVE Fitted with the Marine armour kit, which was designed to protect against small-arms fire and improvised explosive devices (IED), this Humvee was photographed in downtown Fallujah. *(US Department of Defense)*

provides the highest levels of armoured protection available for the Humvee. Described by AM General as being 'IAP ready', the M1100 vehicles incorporate the 'A kit' of basic armour, which is fitted in the factory and is designed to allow further armoured protection to be added, and removed, in the field using the 'B kit'. With both kits installed, the vehicle offers all-round ballistic and mine protection, and an additional fragmentation kit is also available to provide further protection when required.



Experimental variants

XM1124 hybrid electric Humvee

In 1987 the Defense Advanced Research Projects Agency (DARPA) initiated a study into the possibilities of developing hybrid electric military vehicles. Seven companies were selected by DARPA to form a consortium for the development work, collaborating on around 300 projects between 1993 and 1998. One of DARPA's goals was to produce a hybrid electric Humvee that would be capable of travelling up to 25 miles (40km) on full electrical power and would be able to average 25–30 miles per gallon (9–11km per litre) in hybrid mode. The first prototype appeared in 1993, and by 1999 the vehicle had been developed through two further generations, although none was considered to be sufficiently promising for production.

DARPA transferred its electric and hybrid vehicle technology programme to the Department of Transportation (DOT) during the fiscal year 1999, with the Tank-Automotive Research, Development and Engineering Center (TARDEC) in Warren, Michigan, managing the hybrid vehicle programme for the Army. During March 2002 PEI Electronics of Huntsville, Alabama, provided a demonstration hybrid electric Humvee that had been developed to power the Sentinel radar system. Additional prototypes were costed into the defence budget for the years 2004–6 and by this time the US Army was projecting a requirement for 1,500 hybrid Humvees for the scouting role, and 19,000 hybrid shelter carriers.

Described as the XM1124, the vehicle was based on the M1113 chassis from which the standard diesel engine and transmission had been removed and replaced by a hybrid electric driveline. The first prototype was equipped with a four-cylinder 134bhp Peugeot diesel engine coupled to a UQM 55kW generator and four 75kW UQM propulsion motors, one per wheel. In the second version the diesel engine was installed in conjunction with a UQM 75kW generator and two 75kW propulsion motors, one per axle. Each UQM motor or generator was controlled by a UQM electronic inverter. There was also a separate 15kW generator for sensors and communications gear. A further four vehicles were constructed along the lines of the second prototype, with an all-electric range of just six miles (10km). Two of these participated in exercises with US air-assault troops at Fort Campbell, and another was displayed at the annual meeting of the Association of the US Army in Washington DC in late 2005. The XM1124 prototype also participated in air-assault field experiments carried out during September and November 2007, at Fort Benning, Georgia.

By November 2009 the US Army announced that it had selected EnerDel to develop new batteries for the XM1124, awarding the company a $1.29 million contract. With overall design responsibility subcontracted to DRS Technologies, it was stated that EnerDel would work with TARDEC and DRS for a period of 18 months to help develop four prototype power systems for the hybrid vehicle. At the time of writing (summer 2013), assessment continues with a view to the possible deployment of hybrid electric vehicles on suitable missions at some time in the future, but as yet no announcement has been made regarding a likely date for production of the XM1124, which remains a test-bed for the developing technology.

Cab-over heavy Humvee variant

In late 1990 AM General produced two prototypes of a Humvee-derivative 'cab-over' 4x4 cargo vehicle using as many components as possible from the standard M998 series. Dubbed the 'cab-over heavy HMMWV variant', or

BELOW The XM1124 hybrid electric Humvee used the M1113 chassis, but fitted with a hybrid electric driveline. The first prototype used a diesel engine and generator to drive four 75kW propulsion motors, one per wheel; in the second version just two motors were used, one per axle. The all-electric range was just six miles (10km). *(Elizabeth Carnegie; TARDEC)*

'COHHV', the company believed that this truck, rated at 2.5 'short' tons, would satisfy a perceived international requirement for a lightweight, high-mobility cargo vehicle with a payload capability significantly above that of the standard variant. A sales leaflet was published in August 1990, describing the vehicle as a 'cab-over cargo truck'; some contemporary documentation refers to this variant as the M998A4.

The two prototypes were put through durability and performance trials by the company, and in the following year a further nine pre-production machines were produced. Six of these were submitted to the US Army for testing at Aberdeen Proving Ground, and at least one found its way to the Waterways Experiment Station – headquarters for the US Army Engineer Research and Development Center. Of the remaining three, two were delivered to the Belgian government for testing under their VTMTT programme – in fact, one of the AM General photographs of the pre-production vehicle shows it carrying a Belgian communications shelter.

Featuring a distinctive short-nosed forward-control cab with seating for three, body styles were planned to include a steel drop-sided pickup or flat-bed truck with a 120x80in (3,050x2,032mm) bed, a troop carrier using two rows of outward-facing benches, and a shelter carrier for the US 'standard integrated command post' (SICP) or other shelter. The vehicle was also planned to be available as a chassis-cab to allow users to fit specialised bodies.

The chassis was derived from the XM1097 heavy Humvee variant that was being developed at the same time, albeit the wheelbase was extended to 199in (5,055mm).

RIGHT Prototyped in late 1990, the cab-over heavy Humvee variant (COHHV) used the maximum number of standard Humvee components necessary to offer a payload of 2.5 tons. Two prototypes and six pre-production machines were built, but there was no series production. *(AM General)*

Axle and suspension arrangements were unchanged, giving the same 16in (400mm) ground clearance, but the differentials were redesigned to reduce the chances of failure due to overloading. The brakes were also up-rated and the two-piece wheels were strengthened. The 'cab-over engine' configuration meant that the advantage of the low overall height of the original Humvee was lost.

In the first two prototypes, the automotive equipment was similar to that used in the standard Humvee, with a 6.2-litre V8 diesel engine driving through a three-speed automatic transmission coupled to a new two-speed transfer case, which included a power take-off. Presumably these vehicles were felt to be a little underpowered, for the nine pre-production machines that followed used the 6.2-litre turbocharged V8 diesel engine that was subsequently used in the XM1113 'expanded capacity vehicle' (ECV) and in all Humvee 'A2' variants. In this case, the engine was installed in conjunction with a four-speed automatic transmission.

The two original prototypes borrowed windscreen and door details from the standard Humvee, giving a degree of family resemblance, but the COHHV cab was flat-sided and boxy in appearance with a two-part grille. For the nine pre-production machines, the short, stubby nose was slightly softened at its edges and given diagonal moulding lines which picked up styling cues from the standard version, whilst the grille was replaced with a single vertically slotted component that looked more like the standard offering. The vinyl-covered doors of the prototypes were replaced with standard rigid doors, but the distinctive curve-topped windscreen remained. Optional equipment was to include a central tyre-inflation system (CTIS), and a 9,000lb (4,090kg) hydraulic winch or a 9,500lb (4,320kg) electric winch.

The vehicle was to be priced at around $30,000, and at one time it was said that production was scheduled to begin in 1991. The date was progressively pushed back, and at one point the company stated that a 'government production decision is scheduled for mid-1995', but the project was eventually abandoned without any series production. The fate of the prototypes is not known, although photographs

of one of the original two vehicles to be built have emerged showing a 6x6 driveline.

A3 variants

In late 2000 AM General was awarded an $11.5 million contract to develop a Humvee A3 variant to include electronic engine control, a new transmission, anti-lock brakes and improved suspension. A total of ten vehicles were delivered, but although some of the proposed modifications were carried over into existing production variants, there was to be no A3 series.

ECV2 variants

During 2008 AM General delivered the first 15 examples of 25 second-generation expanded-capacity vehicles (ECV2) to Aberdeen Proving Ground for testing. Notable modifications included additional blast protection under the crew compartment, variable-height semi-active suspension and raised floor and rooflines. The engine was described as a GEP SCCS 400 turbocharged unit and was up-rated to produce 250bhp. The standard four-speed transmission was replaced by a six-speed Allison 2550 automatic transmission unit with traction-control features.

The programme was abandoned by the US Army in mid-2009, but AM General continued the development work and have stated that the ECV2 is ready for production.

Third-party adaptations

AM General has partnered other leading defence contractors to help in the development of specialised armoured vehicles derived from the Humvee platform.

Alvis Shadow

Developed for the British Army against a 1994 Ministry of Defence specification for a long-range reconnaissance vehicle, the Alvis Shadow Offensive Action Vehicle (SOV) was originally constructed in conjunction with the South African company Reumech, using the chassis of that company's Cheko-A-Wagen. This project was eventually abandoned, and a new design of Shadow appeared in 2000 based on a shortened and narrowed version of the Humvee M1113 ECV platform. Two prototypes were constructed, and displayed at various defence exhibitions, as well as being offered as a police and security vehicle.

The GM 6.5-litre V8 diesel engine and four-speed automatic gearbox of the donor vehicle were retained, as were the independently suspended front and rear axles. A roll cage/weapons mount was added, together with a drop-down tailgate that could double as a workbench. A front-mounted electric winch was fitted as standard, and customers were encouraged to choose their own weapons systems. The reductions in length and width when compared to the Humvee enabled two Shadows to be carried in a CH-7 Chinook helicopter, or three in the fuselage of a C-130 Hercules transport aircraft; the Shadow could also be air-dropped on a medium stressed platform.

The vehicle was not adopted by the British Army, and as far as is known no sales were achieved. The prototypes were eventually disposed of, with at least one being preserved in private hands.

ABOVE Two examples of the Humvee-based Alvis Shadow were built in 2000 using a shortened and narrowed version of the Humvee M1113 ECV platform. Although it was offered to the British Army as a possible long-range reconnaissance vehicle, it was not adopted. One of the prototypes is in private hands. *(Simon Thomson)*

MOWAG Eagle

Constructed by MOWAG Motorwagenfabrik AG of Switzerland, and based on the 'heavy' Humvee platform, the Eagle is a relatively low-cost lightweight armoured reconnaissance vehicle designed for surveillance, escort, border patrol and police duties. The armoured superstructure is protected against 5.56mm and 7.62mm rounds and provides accommodation for four personnel, whilst the rotating cupola includes a thermal-imaging camera, a 7.62mm machine gun and six grenade-launcher tubes. Weighing 8,580lb

RIGHT Based on the 'heavy' Humvee platform, the MOWAG Eagle is a relatively low-cost lightweight armoured reconnaissance vehicle for surveillance, escort, border patrol and police duties. This example, in service in Switzerland, was photographed during 'Exercise Protector 2009'. *(Carl Schulze)*

BELOW Side view of the MOWAG Eagle, showing the roof-mounted observation cupola. The armoured hull was designed and manufactured by MOWAG, and provides protection against 7.62mm ball ammunition at 33 yards (30m) and 7.62mm steel-core rounds at 110 yards (100m). *(Carl Schulze)*

(3,900kg) empty, and capable of carrying a payload of 2,640lb (1,200kg), the vehicle can be carried in a CH-7 Chinook helicopter or C-130 Hercules transport aircraft.

Power was originally provided by the standard 6.5-litre normally aspirated V8 diesel engine, coupled to a four-speed automatic transmission, but the upgraded Eagle II and III variants – the latter equipped as an artillery forward observation vehicle – used the turbocharged version of this engine.

Otokar Cobra

Based on the Humvee expanded capability (ECV) chassis, the Cobra armoured platform provides the basis for a family of light armoured vehicles manufactured by Otokar Otubüs Karoseri Sanayi AS of Istanbul, Turkey.

The hull has been designed to provide all-round protection against rifle and machine-gun fire and shell fragments, and the shape of the hull is also designed to minimise the effects of anti-personnel mines, anti-tank mines and fragmentation rounds. Various weapons can be mounted including 7.62mm and 12.7mm machine guns, 40mm grenade launchers and cannons up to 30mm calibre. Power comes from the 6.5-litre turbocharged V8 diesel engine, coupled to a four-speed transmission. An optional amphibious kit is available consisting of dual hydraulic thrusters with joystick control.

BELOW Constructed in Turkey by Otokar Otubüs Karoseri Sanayi using the Humvee expanded capability (ECV) chassis, the Cobra armoured platform provides the basis for a family of light armoured vehicles. *(Otokar)*

TABLE 2: HUMVEE EXPERIMENTAL VEHICLES AND MODIFICATIONS	
Designation	**Description**
Experimental vehicles – no production	
COHHV	Cab-over heavy Humvee variant (M998A4); 2.5-ton cargo truck; produced in low-bed, flat-bed and chassis-cab variants
M998A4	*See COHHV, above*
XM1124	Hybrid diesel-electric powered HMMWV, based on M1113 chassis
-	Carrier, 10-man infantry unit
-	Light wrecker with winch, based on M1038 chassis
-	Stinger missile resupply vehicle
Third-party vehicles derived from Humvee chassis	
Alvis Shadow	Offensive action vehicle
MOWAG Eagle	Armoured reconnaissance vehicle
Otokar Cobra	Light armoured vehicle
Third-party modifications	
Ricardo Engineering	Re-powered HMMWV using Steyr M16 TCA 3.2-litre six-cylinder diesel engine, GM 4L80-E four-speed automatic transmission, and 242HD transfer box

The use of a common platform minimises driver training and servicing issues, and the Cobra family includes vehicles suitable for the personnel carrier, reconnaissance, surveillance, command and control, command post, explosive ordnance disposal (EOD), ambulance and weapons carrier roles.

The civilian Hummer

Originally developed as a 'pure' military vehicle, the Humvee was exempted from the need for emissions certification by the US Environmental Protection Agency (EPA). Three Humvees were bought by the US Forest Service in 1990, and one purchased by the Michigan Department of Natural Resources as a 'go-anywhere fire truck', but AM General had no intention to offer the vehicle to civilians.

But the pressure was building. Following widespread exposure on TV news during the Iraq War at the end of 1990/91, half a dozen US newspapers picked up on Kevin Maney's Gannett News Service story suggesting that the Humvee was the ideal car for the 'baby boom generation', describing it as an 'urban dune buggy' or a 'yuppie hauler for the 1990s'.

Despite being 'deluged with letters and phone calls', AM General remained coy – speaking for the company, director of corporate communications Craig MacNab said 'we're looking at it... we're moving that way'. However, 'Terminator' movie star Arnold Schwarzenegger brought matters to the boil when he decided that he couldn't live without a Humvee, seeing it as the perfect accessory for his larger-than-life physique and on-screen personality. Arnie flew to South Bend, Indiana, and made a personal appeal. AM General still refused to supply him with the camouflaged vehicle – complete with weapons mount – that he wanted. It wasn't until he apparently agreed to sign a very long waiver that would absolve AM General from liability, that the company agreed to supply a sand-coloured customised Humvee that was considered to be safe enough for the mean streets of Los Angeles.

Although reputedly delighted with his purchase, Schwarzenegger still wasn't entirely satisfied, and he continued to try to convince AM General to redesign the vehicle for the civilian market. Finally convinced that perhaps there was sales potential, the company relented, and by May 1991 pre-production civilian vehicles were in the hands of the motoring press for evaluation. AM General chose to call the civilian version 'Hummer', a name that the company had originally used to describe the military variants before the US Army decided that Humvee was a better designation. Given the favourable response, in June 1992 AM General announced its intention to market the Hummer to the public and set about putting the pre-production vehicle through an accelerated reliability trial... as well as establishing a dealer network.

In July 1992 Schwarzenegger again flew to Indiana, this time to buy the first two civilian

ABOVE **AM General finally made the Humvee available to the general public in 1992. Described as the Hummer – and latterly as the Hummer H1 – the launch range included a four-door station wagon, a two-door hardtop pickup truck, and a four-door pickup with either hard or soft top.** *(AM General)*

RIGHT **There's no disputing that the Hummer H1 has considerable presence but, with a launch price of $54,700 for the top-of-the-range model, it was never going to be a huge seller. By the time production ended in 2006, just 12,000 or so examples had been sold.** *(AM General)*

Hummers off the production line at Mishawaka. Two months later volume production began.

The line-up initially consisted of four vehicles, all of them broadly based on the M998 cargo/troop carrier – a two-door hardtop pickup truck, a four-door pickup with either hard or soft top, and a four-door utility vehicle or station wagon – with a launch price for the top-of-the-range model of $54,700. Promoted as 'The New American Legend', and powered by the same GM 6.2-litre V8 diesel engine that was found in the military Humvee, the Hummer included virtually all of the mechanical features of its military equivalent, including the central tyre-inflation system (CTIS), and, with good reason, was described as the 'world's most serious off-highway vehicle'.

A package of improvements was announced in 1994 that included repositioned cloth-faced seats, tinted glass, power locks and mirrors, and a lighter rear bumper. At the same time, a petrol-engined option was introduced, using a fuel-injected version of GM's 5.7-litre small-block Chevy V8 engine that was capable of producing 190bhp. Further improvements followed in 1996 with the adoption of the 6.5-litre diesel engine, which was also available with a turbocharged option, and a four-speed gearbox. The petrol engine option was discontinued at more or less the same time.

In 1999 AM General announced that it had signed an agreement with General Motors that would see production of both the military and civilian vehicles continue at Mishawaka, but marketing of the civilian version – which GM now chose to express as HUMMER – passed over to GM. The plant was extended and additional staff were employed.

Hummer H1, H2, H3

Up until this time, the civilian Hummer had borrowed heavily from its military cousin, sharing driveline components and body panels, but in January 2002 GM announced that a new strictly civilian variant would be produced under the brand name Hummer H2, and constructed on a heavily modified GMC 2500HD chassis. Bearing only a passing resemblance to the original military vehicle, and sharing nothing in the way of components, the H2 was powered by a GM Vortec 6-litre high-output V8 petrol engine; a later upgrade saw the engine enlarged to 6.2 litres. Production of the H2 ended in 2009, by which time some 152,000 vehicles had been produced.

With the launch of the H2, the original civilian version was designated Hummer H1.

In 2004 Perkins Technology Consultancy, the engine consulting arm of Perkins Engines, working with CAT Electronics, completed a series of technical modifications to the engine of the H1, including reducing exhaust emissions to meet the stringent 2004 highway emission regulations. Testing of the modified Hummer

LEFT The Humvee was always considered to be a formidable off-road vehicle, and in 1993 Team Hummer Racing was created under the leadership of off-road racer Rod Hall, with some notable class wins in various events. In 2006 a highly modified, two-wheel-drive Hummer was raced by Robby Gordon in the Dakar Rally for the first time; the vehicle secured third place in 2009 and continues to compete in this event. *(Maindru Photo)*

LEFT In 1999 AM General licensed production of the civilian Hummer to GM, and three years later a new civilian variant was launched under the brand name Hummer H2. Based on a heavily modified GMC 2500HD chassis, the new vehicle shared just a passing resemblance to the original military vehicle. Production of the H2 ended in 2009, by which time some 152,000 vehicles had been produced. *(IFCAR)*

RIGHT Described as a mid-sized sport utility vehicle (SUV), the Hummer H3 was launched by GM in 2005. Smaller in size than both the H1 and the H2, the H3 was powered by a five-cylinder engine driving all four wheels through a manual or automatic transmission. A pickup version, designated H3T, was launched in 2009. *(NHTSA)*

was as rigorous, with Perkins cold-testing the vehicle at -40°F (-40°C) in the frozen wastes of Northern Canada and driving it through Death Valley, California, in scorching 122°F (50°C) heat. Despite a tight, 24-month timescale, the design team delivered an engine that was quieter, more powerful, more economical and more reliable, and which was able to meet the statutory emissions.

Production of the H1 finally came to an end in 2006, with total production somewhere in the order of 12,000 vehicles, including 494 built for the US Customs & Border Protection Service. By the time production ended, the top-of-the-range and extensively re-engineered Hummer H1 Alpha that had been introduced the previous year, and which was powered by a 6.6-litre GM Duramax turbocharged diesel engine producing 300bhp, was priced at an eye-watering $150,975.

The final iteration of the civilian Hummer concept was the Hummer H3 that was introduced in 2005. Smaller in size than both the H1 and the H2, and described as a mid-sized sport utility vehicle (SUV), the H3 was powered by a 3.5-litre five-cylinder engine driving all four wheels through a five-speed manual or four-speed automatic transmission. In 2007 the five-cylinder engine was upgraded to 3.7 litres, bringing an increase in power from 220bhp to 242bhp, and a year later, the H3 Alpha model was introduced, powered by a 5.3-litre V8 with four-speed automatic transmission. A pickup version, designated H3T, was launched in 2009. The H3 was produced both at Shreveport, Louisiana, and in Port Elizabeth, South Africa, and remained in production until 2010, with a total of almost 160,000 vehicles constructed.

Financial difficulties at GM saw the Hummer brand in deep trouble, and in June 2009 General Motors announced that it intended to sell the brand to the Chinese Tengzhong company as part of its bankruptcy settlement. Less than a year later, Tengzhong stated that it had withdrawn its bid since it was unable to gain approval from the Chinese government. Unable to attract another buyer, in February 2010 GM announced that it would shut down Hummer production, with the last vehicle, a Hummer H3, coming off the production line at Shreveport on 24 May 2010.

It should, perhaps, be emphasised that although the Hummer H1 is a very close relation of the original military Humvee, the Hummer H2 and H3 share nothing with the original beyond aspects of a certain 'butch' appearance.

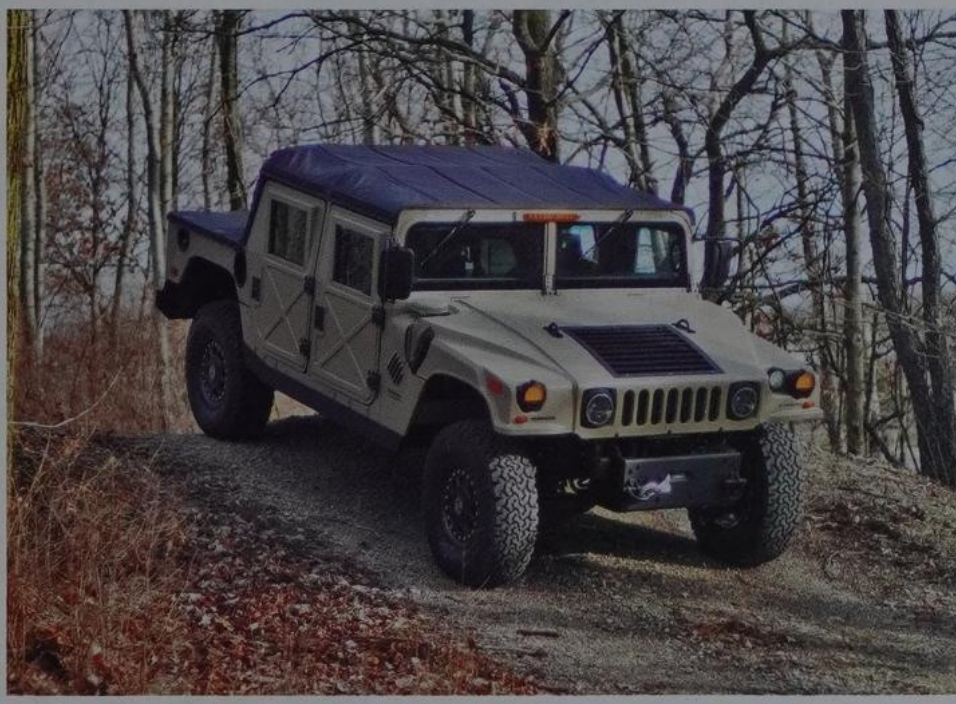
Humvee C-Series kit

US government orders for new Humvees terminated in December 2010, and, faced with the stark reality that production could not be maintained at previous levels based on overseas contracts, AM General announced that it would have no option but to lay off staff. Several hundred of the company's 2,000-strong workforce have been made redundant since that time, with the last batch of around 100 lay-offs coming in December 2012.

However, in October of that year Jeff Adams, a spokesman for the company, told the press that 'we continue to work on finalising the first

of a number of international opportunities which will extend HMMWV production well into the foreseeable future'. One of these 'opportunities' had already been announced back in August 2012, when the company launched the civilian Humvee C-Series kit, a civilian off-roader consisting of a fully assembled military-style rolling chassis and body, a soft top and a painted body with a fully trimmed interior; the body can be supplied in a choice of khaki, green or sand. Customers can build this into a street-legal vehicle by adding their own engine and transmission. By including none of the technology that was created specifically for the civilian Hummer H1, the C-Series does not step on GM's toes. And, similarly, by offering the vehicle as a kit AM General has neatly side-stepped the US Environment Protection Agency (EPA) emissions standards and US government safety regulations that had played a role in shutting down the production of the Hummer H1 in 2006.

At launch, the price of the C-Series base kit was set at $59,950, with availability scheduled for spring of 2013, with the price guaranteed for the first 50 kits ordered. Obviously aware of the possibility of 'shooting itself in the foot', AM General was keen to point out that the C-Series kit would not be sold to military customers.



ABOVE In August 2012, AM General launched the civilian Humvee C-Series kit. Looking for all the world like a military Humvee in civvy clothing, the C-Series consists of a fully assembled rolling chassis and body, a soft top and a painted body with a fully trimmed interior; the four-door body can be supplied in a choice of khaki, green or sand. *(AM General)*

BELOW Priced at $59,950 at the time of launch, the C-Series kit is supplied without engine and transmission. However, since these items are shared with the Chevrolet C/K pickup truck their acquisition should not present too much of a challenge. *(AM General)*

'The US Armed Forces' high-mobility multi-purpose wheeled vehicle is built in a modern facility dedicated exclusively to production of this versatile new answer to the need for superior mobility in a tactical field environment.'

AM General. Press release, 21 February 1985

Chapter Three

Manufacture

The first Humvee contract was awarded to AM General by the Tank-Automotive and Armaments Command (TACOM) on 22 March 1983, calling for an initial 2,434 vehicles to be delivered over a five-year period at an overall price of $59.8 million. This contract was subsequently extended to cover 54,973 vehicles at a cost of $1.2 billion, with some 39,000 vehicles intended for the US Army, and the remainder shared between the US Navy, the Air Force and the Marine Corps.

OPPOSITE US Air Force personnel who are students in the Air Force Phoenix Warrior Training Course 07-4 drive in a convoy as part of class operations at the Naval Air Engineering Station in Lakehurst, New Jersey. The lead vehicle, which sports an interesting brush guard and a bridging plate on the engine cover, is an early production M1026 winch-equipped armament carrier. *(US Department of Defense)*

ABOVE Fitting armour on the factory production line to an M1151 expanded capacity armament carrier. *(AM General)*

Production of the HMMWV began in the autumn of 1984, with the first vehicle completed on 5 January 1985. For this first phase of the production contract, the unit cost per vehicle worked out at around $25,000, close to double the price of the M151 Jeep that it replaced. A second extension to the contract brought the total to 70,000 vehicles, making this by far the largest multi-year contract for tactical military vehicles ever awarded by the US Army. Clearly this was good news for the Ling-Temco-Vought (LTV) Missiles & Electronics Group, which owned AM General at the time: despite the parent company making a loss of $100 million in the first quarter of 1985, LTV Aerospace and Defense managed to post a $124.8 million profit for the year with future prospects described as 'good'.

In September 1988 TACOM issued a revision to the original Humvee acquisition plan, pointing out that the previous arrangements, which had been approved on 27 April 1987, had not been implemented due to funding constraints, necessitating the elimination of acquisitions during fiscal years 1990–92. When this funding was reinstated, a new multi-year contract was drawn up and issued for approval. The contract, which it was envisaged would be awarded in July of the following year, called for deliveries to start 13 months after the contract was awarded at a production rate of 35 vehicles a day. It was not a foregone conclusion that the contract would go to AM General, although it was pointed out that this would obviate any lead-time. It was also stated that whoever won the contract must assemble the vehicles in the USA or Canada, with major components such as the engine, transmission and transfer case manufactured in the USA or Canada.

AM General was awarded the second contract in August 1989, covering 33,331 vehicles at a total price of around $1 billion, with deliveries scheduled to begin in January 1990 and to continue into 1993. By this time the average cost per vehicle had climbed to slightly more than $30,000. This contract was also extended, eventually covering 100,000 vehicles over a five-year period. By mid-1991 more than 72,000 vehicles had been constructed, with

the total reaching 100,000 by 1995. Although the contract originally stated that 'the Humvee, in all current configurations, is fully defined by the existing contract and purchase description', production eventually switched to the A1 variant in 1992, with the A2 following in 1995.

The third contract came in late 2000, with 2,962 vehicles scheduled for delivery during 2001 at an average price of $30,725 per vehicle. Although the total initial value of this contract was $191 million, there were six one-year options covering a total of 31,474 vehicles, with deliveries scheduled to continue into 2007. Production switched to the A3 variant in 2002, with new vehicles integrating those technology upgrades that were required to meet the new Humvee 'operational requirements document', and in 2007 the contract was further extended to cover 85,000 vehicles, running through to 2009.

Three contract modifications were issued in September 2005, the first covering M1151 and M1152 variants for the US and Iraqi Armies, as well as a quantity of up-armoured M1114 variants for the Iraqis. The second and third modifications covered production of M1114 and M1043A2 variants. More modifications followed during 2006 and 2007, covering quantities of M1151A1, M1152, M1165, and M1165A1 variants. In 2010 two further contract extensions were announced – the first calling for 500 vehicles, the second covering 153 vehicles – and a new contract was issued for a further 8,995 vehicles.

Series production of the Humvee for the US Army and the Marine Corps ended in 2010, although contracts were issued by the Pentagon in August of that year covering 2,526 Humvees for the Afghan Police Force and National Guard, with a projected completion date of 31 December 2013. During 2011 AM General also received a number of fixed-price contracts from TACOM for modification and rebuilding of existing Humvee models.

By the end of 2012 AM General had constructed more than 281,000 vehicles, with an average price per vehicle of around $50,000. An inventory published earlier in the year showed that US Army stocks stood at around 160,000 vehicles, with a further 25,000 or so with the Marine Corps.

Production

AM General

The origins of what is currently known as AM General can be traced back to 1903, when the Standard Wheel Company of Terre Haute, Indiana, decided that there was more money to be made from producing motorcars than bicycles. The company's first motor vehicle was the Overland Runabout. In 1908 Overland was purchased by John North Willys, and the Willys-Overland Company was founded four years later when the operation was moved to Elyria, Ohio, where Willys owned the former Garford plant. In 1915 Willys moved production to Toledo, Ohio, although the engines continued to be built in Elyria. Production began with a four-cylinder model priced at around $2,500 and, between 1913 and 1932, Willys-Overland established a reputation for its Willys-Knight series of vehicles, fitted with sleeve-valve Knight engines. From 1933 the company ceased production of vehicles in the higher price bracket and started to produce the inexpensive Willys 77.

In 1940 Willys-Overland was rescued from financial difficulty by its involvement in producing prototypes and bidding for production of what became known as the Jeep – one of the few genuine icons of 20th-century motoring. Between 1941 and 1945 Willys built some 361,349 Jeeps alongside the Ford Motor Company, whose contribution amounted to 277,896 examples. Despite having been the first to produce a Jeep prototype, American Bantam – the third company involved in the project – was never considered large enough to be included in the production process. Jeep production continued after the war, with the civilian CJ series and the military M38 and M38A1.

The Willys-Overland Company, including its plant and facilities, was bought by Henry J. Kaiser in 1953, subsequently becoming the Kaiser-Jeep Corporation. A decade later the redundant Studebaker factory at South Bend, Indiana, was acquired, together with a contract to construct 2.5-ton 6x6 M35 and M44 series military trucks. From 1962, and into the 1970s, the company also built large numbers of the Ford-designed M151 and M151A2 utility vehicle, together with other tactical trucks including the

5-ton M39 and M809, the 1.25-ton M715 series and the M274 'Mechanical Mule'.

Kaiser-Jeep was bought by the American Motors Corporation in February 1970 and was renamed the Jeep Corporation and split into two divisions – the Commercial Products Division in Toledo, and the Defense & Government Products Division at South Bend, the latter being spun-off as the AM General Corporation the following year with the aim of producing military vehicles, postal delivery vehicles and buses. By 1977 AM General consisted of three divisions – the Truck Division, Transit Division and Technical Services Division – with four plants and with 3,000 employees operating in some 2,500,000ft² (233,000m²) of production space.

Work on what eventually became the Humvee project began in 1979, with AM General selected as one of three companies constructing prototypes. In 1983, having already secured the first Humvee production contract, AM General was acquired by the Dallas-based LTV Corporation – Ling-Temco-Vought – and was established as a wholly-owned subsidiary of the LTV Missiles & Electronics Group, before becoming an arm of LTV's Aerospace & Defense Company. In 1984 the AM General headquarters had been relocated from the former American Motors AMTEK Building to Livonia, Michigan, before moving again to South Bend, Indiana, in 1986, where the primary manufacturing operations were located. Change seemed to be a permanent way of life at AM General, and in 1989 the company closed the Chippewa Avenue facilities in South Bend that had been acquired from Studebaker in 1964, and early the following year moved the corporate headquarters to downtown South Bend.

Humvee production took place at Mishawaka, near South Bend, in a renovated 394,000ft² (36,650m²) plant in which AM General had installed a 6,000ft (1,830m) production line. The plant had originally been built by Rockwell-Standard in 1956 to manufacture vehicle bumpers and had been purchased by AM General in 1968 when it was used to build transit buses until 1978; production thereafter was moved to Texas. The plant had also been used to fabricate and assemble cargo and dump bodies for AM General's M-Series military trucks and, having stood idle for five years, was reopened in 1984 following a $15 million, 15-month refurbishment programme led by AM General's Dick Flood. A dedication ceremony was organised by the company at a private function on Sunday 30 September 1984, with an address by Robert L. Kirk, president of LTV Aerospace & Defense. The event included a picnic and plant tours for 2,000 employees and their families, and a scale model Humvee was presented to US Army Secretary John O. Marsh Jr after he pressed the button that started production of the new vehicle.

RIGHT Aerial view of the AM General factory complex at Mishawaka, near South Bend, Indiana. Humvee production was moved to the new 550,000ft² (51,100m²) plant in 1990. *(AM General)*

The plant was dedicated to manufacturing the Humvee, and included what was described as 'state of the art manufacturing technology, with extensive use of robotics and computerisation', and automated drilling and riveting equipment. Robot technology had started to appear in vehicle plants in the 1970s, and the process of installing robots was in full swing by about 1984 – of the eight robots installed at Mishawaka, four were devoted to paintwork, the other four to fillet welding. Other innovations included the elimination of off-line repair stations, rapid feedback systems for on-line correction of defects, and the use of a rolling road that allowed every vehicle off the line to be 'road-tested' for 10 miles (16km). Every 50th vehicle was also put through a 50-mile (80km) evaluation. Final approval of completed vehicles was the responsibility of an initial six-man team of inspectors from the Defense Contracts Administration Service (DCAS) located in the plant. When production started, the DCAS supervisor was Dwight Manns, whilst AM General's quality assurance director was the aptly named James Armour.

Some 250 staff that had been laid off from AM General's South Bend plant were the first to be hired, with training reported to take somewhere between three and five days. A further 250 staff, both skilled and unskilled, were hired during September 1984, and by the time production was in full swing in 1985 the plant was employing some 800 personnel. The company secured concessions from the local branch of the United Auto Workers union that were said to be key to securing the contract.

It was predicted that the Humvee contract would create a further 2,000 jobs outside the plant at suppliers located in Indiana, Michigan and Ohio. Amongst these companies, key sub-contractors included: General Motors, who supplied the engines, automatic gearboxes and (Saginaw) steering equipment; the New Process Gear Company, manufacturers of the transfer case; Gleason Power Systems, who produced the torque-sensing differentials; Saginaw Eagle-Pilcher Plastics, suppliers of the press-moulded engine cover; Orrville Products, who produced the tailgate; Felstead Products IPP Division; and Excel Industries, the last-named supplying doors.

The first completed Humvee, in the form of a two-door M998 cargo/troop carrier, rolled off the production line on 2 January 1985, with the company confidently predicting that by mid-year production would reach 65 vehicles a day, with a theoretical potential for the plant said to be 60,000 vehicles a year. Deliveries to the armed forces were scheduled to begin in the spring of 1985.

In 1990 Humvee production was moved to a new 550,000ft² (51,100m²) plant at Mishawaka. Here, the vehicles were constructed by robots according to a process described by the company as 'lean manufacturing', with a theoretical maximum production rate of 100 vehicles per shift. Both the military Humvee and the civilian Hummer H1 were manufactured in the Mishawaka plant on the same production line. Following a 10-mile (16km) road run, the civilian vehicles were returned to the separate Armour Building where the final stages of the production process were carried out, including final painting and trimming. The plant included on-site test-track facilities, as well as an indoor test facility that allowed stationary vehicles to be run on a rolling road. At the same time, new scheduling and production software was introduced running on Tandem computers. The software catalogued materials received, matched these against shop-floor requirements and tracked the production process.

In April 1992 AM General was acquired by the New York-based Renco Group. In August 2004 MacAndrews & Forbes Holdings and the

BELOW Production of the civilian Hummer H1 took place at the Mishawaka plant on the same production line. Following a 10-mile (16km) road run, the civilian vehicles were returned to a separate building for final painting and trimming. *(AM General)*

Renco Group announced the formation of a new venture, dubbed AM General LLC, and in 2007 AM General and General Dynamics Land Systems – competitors on the original Humvee project – formed a joint venture named General Tactical Vehicles to compete for the US Army and Marine Corps joint light tactical vehicle (JLTV) programme.

Humvee production slowed right down at the end of 2010 when the final US Army contract was completed, although the US Army's 2011 spending plan included $989 million to be spent on maintenance, parts and service for the existing fleet of Humvees. The Mishawaka plant was shut down on 1 October 2012 for an initial two-week period, which was subsequently extended for a further two weeks, but is currently (summer 2013) being used for the assembly of the MV-1 mobility vehicle, a commercial taxi designed to comply with the vehicle guidelines of the 'Americans with Disabilities Act'.

The AM General business currently also includes two wholly owned subsidiaries, General Engine Products, incorporated in 1999 to produce diesel engines, and General Transmission Products, producing automatic transmission assemblies. All of the company's vehicle assembly plants have achieved ISO 9001:2000 registration from the Quality Management Institute, and the Humvee was the first tactical military vehicle to meet this standard.

BELOW In 1999, AM General established General Engine Products (GEP) to produce the Optimizer 6500 V8 diesel engine at a 92,000ft² (8,583m²) plant in Franklin, Ohio. General Motors had previously constructed this engine at their Moraine Engine Plant, and, as part of the acquisition programme, provided technical support to assist AM General in developing the Franklin works. *(AM General)*

General Engine Products

In July 2000 General Engine Products (GEP) began assembly of the Optimizer 6500 V8 diesel engine at its 92,000ft² (8,583m²) plant in Franklin, Ohio, with full production rate reached in January 2001. The engine had previously been built by General Motors at their Moraine Engine Plant, and as part of the acquisition programme GM provided technical support to assist AM General to develop the new manufacturing plant.

General Transmission Products

The Humvee transmission was originally supplied by General Motors Powertrain, but this was acquired by AM General in 2008 and was subsequently renamed General Transmission Products.

O'Gara-Hess & Eisenhardt

In 1993 O'Gara-Hess & Eisenhardt (OHE) of Fairfield, Ohio, was contracted to develop enhanced protection systems for the M1097A1 heavy Humvee chassis in order to enhance ballistic protection for doors, windows, roof and under-body areas. The up-armoured Humvees also feature heavy-duty suspension systems able to handle the additional weight of the armoured panels and the bullet-resistant glass. However, there were downsides to this increased weight and the result was a negative effect on speed, performance and reliability. In 1995, in an attempt at overcoming these drawbacks, AM General and OHE produced the XM1114 prototype based on the chassis of the M1113 ECV; this vehicle eventually entered production as the M1114 up-armoured Humvee.

O'Gara-Hess & Eisenhardt was originally established in 1876 as Sayers & Scovil, a custom coachbuilder. The company constructed its first motor car body in 1906, moving into the production of commercial armoured vehicles in 1942 under the name Hess & Eisenhardt, before subsequently specialising in vehicle armour and personnel protection systems. The name was changed to O'Gara-Hess & Eisenhardt in 1982 when the original company was purchased by the O'Gara family. In April 2001 OHE became part of the Mobile Security Division of Armor

ABOVE Brand new armoured M1151 variants parked at the factory awaiting shipment. *(AM General)*

Holdings Inc, subsequently becoming part of its Centigon Division. In 2007 Armor Holdings was purchased by BAE Systems plc, with Centigon subsequently sold to Carat Duchatelat Holdings in February 2008.

OHE is also one of a number of companies producing two- and four-door armour and blast kits to convert existing vehicles. The company has manufacturing facilities in Mexico, Brazil, France, Germany and Mexico, as well as in the USA.

Overseas sales

Even before production was fully under way, AM General was clearly well aware of the international potential of the Humvee and the vehicle was featured in the 1983 *United States Defense Equipment Catalog*, where it was described as 'the totally new high-mobility multi-purpose wheeled vehicle designed and engineered by AM General... [which will] have profound effects on tactical and strategic military operations throughout the world.'

The Humvee was first shown to an international defence audience at the Farnborough Air Show in Britain on 2 September 1984. Senator Barry Goldwater, Republican senator for the state of Arizona, and Dr Jay R. Sculley, US Army Assistant Secretary for Research, Acquisition and Development, unveiled the vehicle to the assembled press and public, and later drove the Humvee on the nearby DERA (Defence Equipment Research Agency) track. Some 20 US and foreign journalists were also given a chance to drive the vehicle and Britain's *Daily Mirror* newspaper was moved to comment that 'the Jeep has come to the end of the road after 45 years as the world's most famous military vehicle'.

Subsequent export sales have shown that the Humvee has the same level of appeal outside the USA as it does at home. By 1988 the authoritative directory *Jane's Military Logistics* was reporting that Humvees were in service with Abu Dhabi, Djibouti, Luxembourg and Thailand. Within three years *Janes* was reporting that the number of vehicles exported

LEFT As part of the company's export drive, Humvees are regularly shown at defence equipment exhibitions across the world. This armament carrier, equipped with a desert cooling package and central tyre-inflation system (CTIS), was photographed on a purpose-built demonstration track at IDEX in Abu Dhabi. *(Simon Thomson)*

CENTRE Also seen at IDEX, this M1113 four-door cargo/troop/shelter carrier is being put through its paces in the demonstration area. *(Simon Thomson)*

BOTTOM Humvees are manufactured in Greece by ELBO, with some 35 per cent local content. This TOW missile carrier is equipped with the Israeli Plasan armoured protection kit. *(Warehouse Collection)*

was around 3,000, with some 18 countries involved; 'civilianised versions' were supplied to the Chinese Ministry of Petroleum Exploration and to the US Border Patrol service.

The Humvee ultimately went on to serve with more than 50 nations worldwide.

Humvees are also constructed under licence in Mexico by the state-owned Direccion General de Industria Militar, and in Greece by ELBO, the latter with some 35 per cent local content. A licence was also issued to Spanish manufacturer Santana, but no vehicles had been constructed by the time the licence lapsed in 2005. An armoured protection kit for the vehicle is produced by Plasan in Israel and these kits are supplied to ELBO to modify Greek-built Humvees to the armoured configuration.

The Chinese-built Dongfeng EQ2050 and the Shenyang Aviation Motor Corporation SQF2040 were both constructed using Hummer H1 chassis supplied by AM General, but production vehicles are 100 per cent Chinese and are not constructed under any type of AM General licence.

'Recapitalization'

A large proportion of the US Army's Humvee fleet was constructed during the years 1985–2001, and, at the time, it was stated that the anticipated service life of the vehicle was 15 years. By the year 2000 the oldest trucks in

service began to exceed this figure, and by the end of the following year the average age of the fleet had reached 11 years. The increasing age of the vehicles in service was having a knock-on effect on operating and support expenditure, but available funds were being allocated to the acquisition of new vehicles, which meant that the average age of the Humvee fleet would reach 17 years by 2010.

The US Army's Product Manager, Light Tactical Vehicles proposed a programme to 'recapitalize', or rebuild and upgrade, 100,000 older vehicles to return them to near-new condition and, at the same time, to improve corrosion protection. It was hoped that this would extend the useful life of the vehicles by an additional 21 years. The programme was designed to focus on those vehicles that were between 12 and 13 years old. As initially envisaged, the programme included the cost of a new engine and drivetrain, new rust-protected chassis rails and some 50 upgrades, at a cost of up to $40,000 per vehicle.

The scope of this programme was subsequently expanded with the introduction of the Army Recapitalization Policy, which aimed to maintain the average age of the Humvee fleet at a figure that was at or below half the system's expected service life. A mathematical model designed to predict the average age of the fleet, and its status as regards to service life, showed that more than 8,000 vehicles would need to be rebuilt annually for a number of years in order to meet the half-life standard by 2010. In September 2001 it was determined that it was not cost-effective to rebuild the entire fleet according to these criteria and the programme was scaled down to recapitalise a total of 4,372 vehicles starting in 2004. The work was similarly reduced, now covering a rebuild of the engine and drivetrain, and inspection, repair and replacement of key components.

The work was directed towards older M998 cargo/troop carriers and M1037 shelter carriers, rebuilding these into armour-capable M1097s. The first recapitalized vehicles were delivered from Red River Army Depot.

Eventually, the recapitalization programme was extended to include M1038 and M1038A1 cargo/troop carriers, and older M1097 and M1097A1 heavy cargo/shelter carriers, converting these to M1097R1 configuration. At the same time, M1025, M1025A1, M1026 and M1026A1 variants were rebuilt to what was described as M1025R1 standard, latterly involving the use of a new power-train package. By February 2011 a total of 46,339 vehicles had been recapitalized by Red River and Letterkenny Army Depots and the Maine Military Authority, and a pilot programme had been initiated to recapitalize 340 M1151A1 variants with serial numbers below 300,000. By late 2012 the number of vehicles rebuilt had risen to around 55,000.

Towards the late summer of 2011, the recapitalization scheme was being described as the Modernized Expanded Capacity Vehicle (MECV) programme, and in late September 2011 the US Army issued a draft request for proposals describing a two-phase process covering the recapitalization of M1151 vehicles, together with an evaluation of the work involved in the inclusion of M1152, M1165 and M1167 vehicles. The total number of vehicles involved was in the order of 5,750, with the government suggesting that the maximum acceptable price for the work was $4.5 million.

Whilst this work was being planned, the US Army had also been actively pursuing a long-term replacement for the Humvee in the shape of the joint light tactical vehicle (JLTV), and in November 2011 the Secretary of the Army, John McHugh, finally came out and announced that the Army was 'done with the Humvee', and that the anticipated procurement of the JLTV, intended to replace the Humvee from 2015, would mean a reduction in the number of vehicles scheduled for the MECV programme.

On 23 January 2012 the Department of Defense decided that the MECV programme would be cancelled altogether. All sums allocated to the MECV project for 2013 were redirected towards the development of the JLTV.

Marine Corps upgrade

In early 2013 it was reported that the US Marine Corps was similarly searching for a solution to the problems of upgrading its own

BELOW In 2004 a Steyr-powered concept vehicle was produced by the British-based engineering firm Ricardo, and successfully completed hot-weather trials in the United Arab Emirates. Driving through a GM four-speed automatic transmission, the engine was said to produce 33 per cent more power and 40 per cent more torque than the original GM V8. *(Ricardo Engineering)*

combat-weary Humvees – ten years of active service, combined with routine overloading and necessary abuse, have taken their toll on the Corps' 6,700 Humvee ECV variants. A spokesman for the Marine Corps said that they had noted the work being undertaken during the Army's recapitalization project, and were conducting studies at the Nevada Automotive Test Center in Silver Springs in order to decide on the most cost-effective option. Key areas identified for improvement include the engine, transmission and suspension, and the Corps apparently has earmarked a total of $8.1 million for the work during 2014, with additional work, as yet uncosted, scheduled for fiscal years 2015 to 2018.

Somewhere around 4,000 of the older A2 variant vehicles will be disposed of either by sale to foreign governments or transfer to other government departments.

Ricardo Special Vehicles
RICARDO
Ricardo Re-powered HMMWV
The Ricardo Re-powered HMMWV Concept Vehicle successfully completed summer trials in the UAE in August 2004 and 2005 with excellent results. In mid-2005, a small quantity of vehicle conversion kits were supplied for rigorous validation testing in the USA:
• Testbed durability
• Cold and Hot Vehicle chamber
• Trailer tow durability
• Off road capability/durability
• Vehicle performance (speed, acceleration, tractive effort, range)
• Maintenance
The Ricardo Re-powered HMMWV utilises a Steyr Motors' M16 TCA 3.2L straight six engine, which is a compact power unit and can be installed with minimal modifications to the base vehicle.
The powertrain upgrade includes a GM 4L80-E transmission, 242HD transfer box and a Ricardo developed cooling pack. The upgrade focuses on maximising current platform carry-over content and minimum changes to vehicle architecture.
RICARDO HMMWV RE-POWER PROGRAMME - BENEFITS
Re-powering of the HMMWV with the Steyr 3.2L straight 6-cylinder engine provides all round performance enhancements and operational benefits, particularly for armoured and heavily laden vehicles:
Engine Installation:
Modern, lightweight aluminium alloy monoblock Steyr M16 engine with unit injectors
Compliant to Euro II, III and in 2007 Euro IV emission regulations
Proven in military and marine applications
Power and Torque:
Steyr M16 TCA 3.2L, at 160kW and 550Nm provides 33% more power and 40% more torque compared to the standard V8 AM General HMMWV
Acceleration:
Significantly faster acceleration than base vehicle – over twice as quick to 100kph
Speed:
Higher top speed (140+ kph) compared to base vehicle
Fuel economy and vehicle range:
Improvement of over 20% on average
Payload:
Weight savings allow additional payload potential (150+ kg over base vehicle)
Serviceability:
Service and maintenance benefits due to modern engine and significantly improved access compared to the base vehicle V8
Cooling system:
Ricardo's expertise and extensive summer testing has helped develop a superior cooling system to support full engine performance in ambient temperatures over 50°C
Drivetrain self protection:
Reacts to compromised or damaged cooling systems to avoid engine damage and keep vehicle running when really needed.
Excellent poor fuel quality resistance
DELIVERING VALUE THROUGH INNOVATION & TECHNOLOGY
www.ricardo.com

Engineering upgrades

As is often the case with a successful military vehicle, companies other than the original manufacturer eventually become involved, offering, for example, engine and suspension upgrades.

Engine upgrades

In the summer of 2004, *National Defense Magazine* reported that the US Army was investigating the feasibility of retrofitting new engines in an attempt at increasing reliability of the older, up-armoured Humvees, where the ever-increasing weight was taking a toll on both the drivetrain and the suspension. The National Automotive Center was said to be testing four Humvees equipped with a V6 diesel engine produced by the Navistar International Truck and Engine Corporation that had originally been intended for the Ford F-150 pickup truck. At the same time, AM General was also reported to be working on a new 6.5-litre engine for the Humvee. In the event, the Navistar power unit was not adopted and rebuilt Humvees were fitted with the standard 6.5-litre GEP V8 engine, either in naturally aspirated or turbocharged configuration.

During that same year, a re-powered Humvee concept vehicle was produced by the multi-national British-based engineering firm Ricardo, and successfully completed hot-weather trials in the United Arab Emirates. Powered by a Steyr M16 TCA 3.2-litre six-cylinder diesel engine, driving through a GM four-speed automatic transmission, the engine was said to produce 33 per cent more power and 40 per cent more torque than the original GM V8. Ricardo claimed that the conversion would provide 'all-round performance enhancements and operational benefits, particularly for armoured and heavily-laden vehicles'. The engine and transmission were supplied as a complete kit, allowing easy upgrading of existing vehicles with a minimum of modifications required.

Ricardo became involved in Humvee power-train upgrades again in late 2008, when it was announced that TARDEC (Tank-Automotive Research, Development and Engineering Center) was working with Ricardo's Detroit

ABOVE In 2012 Ricardo and TARDEC exhibited this Humvee-based hybrid-electric vehicle at the Society of Automotive Engineers World Congress in Detroit. Dubbed FED-Bravo, it featured a road-coupled parallel hybrid-drive system, with the front axle powered by an electric motor and the rear axle coupled to a hybrid fuel-powered/ electric system. *(Ricardo Engineering)*

office and Select Engineering Services in an attempt to improve the fuel consumption of the Humvee. Ricardo hoped that their 'fuel-efficient demonstrator', dubbed FED-Alpha, might improve fuel consumption by as much as 70 per cent – giving a figure of around 9mpg (3.2km/litre) rather than the 7mpg (2.5km/litre) of the standard M1114 variant. The vehicle was demonstrated in late 2011 and put through a series of trials at Aberdeen Proving Ground in Maryland. FED-Alpha is powered by a Cummins 200bhp turbocharged four-cylinder diesel engine, driving all four wheels through a six-speed automatic transmission; there are special low-rolling-resistance tyres, and a solar panel on the rear hatch can recharge the vehicle's electrical system.

At the same time, a second demonstrator, dubbed FED-Bravo, was also being developed, running on a hybrid-electric drive. Making its public debut at the Society of Automotive Engineers World Congress in Detroit in April 2012, FED-Bravo featured a road-coupled parallel hybrid-drive system in which the front axle is powered by an electric motor, while the rear-wheel drive is linked to a hybrid fuel-powered/electric system. The standard GM engine was replaced by a Ford 4.4-litre twin turbocharged V8 diesel producing 268bhp, driving through a six-speed automatic transmission, coupled to an advanced lithium-ion battery. An integrated starter-generator shuts off the engine during idling and restarts it when the driver touches the accelerator, to improve fuel economy and reduce emissions.

LEFT The Oshkosh TAK-4 heavy-duty independent suspension system for the Humvee is designed to counter the effects of blast from improvised explosive devices (IED). The system also has the additional benefit of increasing the usable payload when armour has been fitted, providing a better quality ride and improving braking by around 50 per cent. *(Oshkosh Truck Corporation)*

Oshkosh TAK-4 suspension upgrade

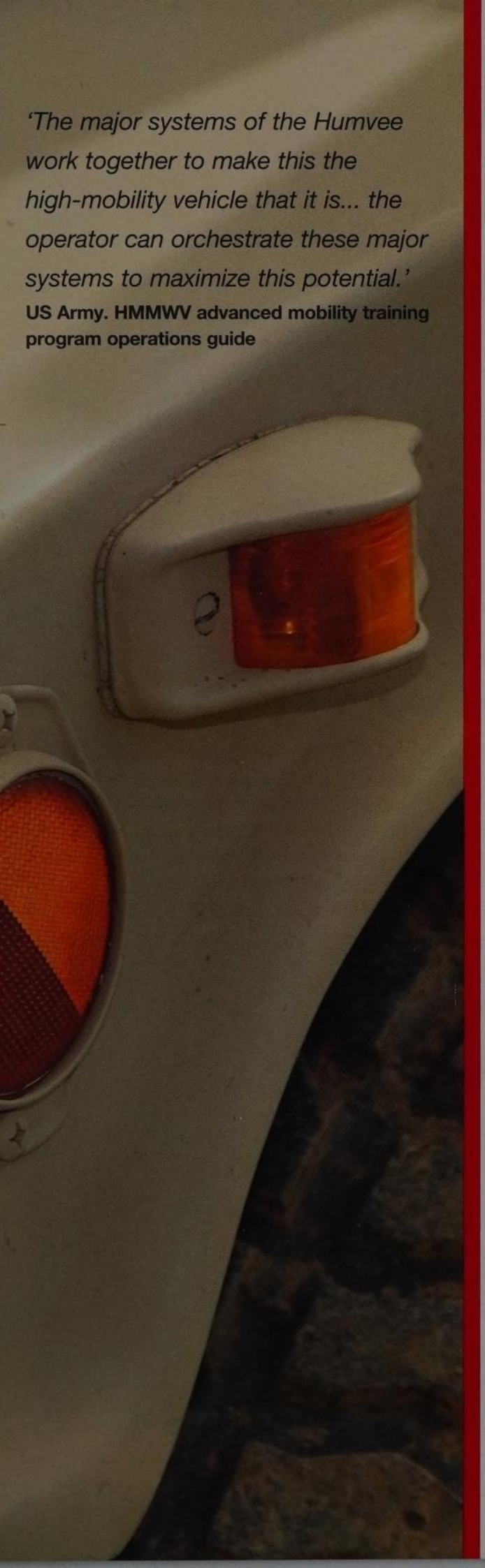
Oshkosh has devised a suspension upgrade package for the Humvee. Designed to counter the effects of blast from improvised explosive devices (IED), the TAK-4 heavy-duty independent suspension system, which has been proven on other military vehicles, increases the usable payload when heavy armour has been fitted, provides a better quality ride, and improves braking by around 50 per cent. With the suspension fitted the ground clearance is increased to 17in (432mm), and a full 14in (356mm) of movement is available at each wheel station, an increase of 5in (127mm).

Oshkosh demonstrated a customised Humvee at Quantico, Virginia, in late 2010, and has offered the TAK-4 suspension to the US Marine Corps as part of a planned package of upgrades.

BELOW Oshkosh demonstrated a TAK-4 modified Humvee at Quantico, Virginia, in 2010, and also offered the suspension to the US Marine Corps as part of a planned package of upgrades. *(Oshkosh Truck Corporation)*

HQ2-A

'The major systems of the Humvee work together to make this the high-mobility vehicle that it is... the operator can orchestrate these major systems to maximize this potential.'
US Army. HMMWV advanced mobility training program operations guide



Chapter Four

Anatomy of the Humvee

Although unmistakeably 'military' in appearance, the Humvee is a handsome enough vehicle with a low, wide stance that combines with the big wheels and tyres to convey a sense of real purpose. It has been described as a 'cross between a fat car and a squat truck', and, whilst being prepared to admit that 'it isn't pretty', the US *Off-Road* magazine also felt moved to point out that it is 'beautiful, however, in its execution, handling, ride and performance'.

OPPOSITE The distinctive press-moulded composite engine cover is manufactured by Saginaw Eagle-Pilcher Plastics, one of dozens of subcontractors to have contributed to the success of the Humvee. *(Phil Royal)*

ABOVE The M998 cargo/troop carrier, and the winch-equipped M1038 seen here, was always considered to be the base model of the Humvee family. Although shown here in four-door open format, soft or hard doors could be specified, or infill panels fitted into the rear door openings. Both high and low covers were produced for the cargo area. *(David Doyle)*

All of the Humvee variants share a common frontal appearance, with a vertically slotted grille that is almost a parody of the grille of the World War Two Jeep. For this reason, the parentage of the Humvee is in no doubt – but in every real respect it is a very much more capable and contemporary machine.

Similarly, do not be deceived by the similarities in appearance between the first Humvees that rolled off the production line back in 1985 and the vehicles that AM General are producing more than 25 years later. A process of continual improvement means that although there is a marked visual similarity between the oldest and the newest vehicles, there is, in the words of Craig MacNab, AM General's director of communications and a former US Army colonel, 'scarcely a nut and bolt on the vehicle that hasn't changed'. Nevertheless, AM General also claims that the 15 different configurations (cargo/troop carriers, weapons carriers, ambulances and shelter carriers) share just five body styles, together with a common engine, chassis and transmission, and that something like 44 interchangeable parts are used in more than one position.

The text that follows concentrates on describing the original M998 series – sometimes referred to as the 'A0' to differentiate it from the subsequent 'A1' and later versions. This is often described as the 'base vehicle' from which all subsequent variants are derived, and is also the most common Humvee in private hands. Where there are differences in later versions, these are described separately.

Chassis

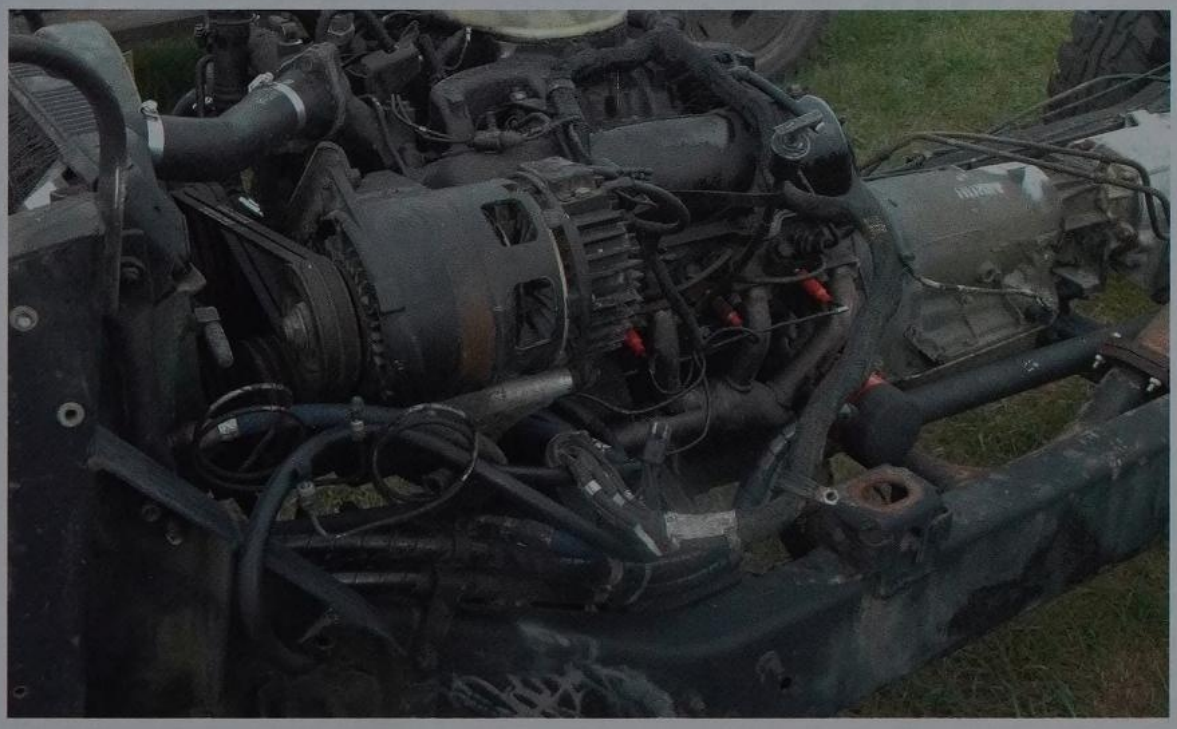
All Humvee variants are constructed on a common chassis, formed from boxed channel sections of electrophoretically coated alloy steel, that carries the engine, transmission and axles, and onto which various body configurations can be installed. From the year 2000 the chassis was given a 15-year warranty against corrosion.

The chassis is of a narrow double-drop design, tapered at the front and rear in such a way as to allow the body to straddle the running gear. Five cross-members are used to brace the main longitudinal channels; the front cross-member was strengthened on the 'A2' and subsequent variants. Provision is

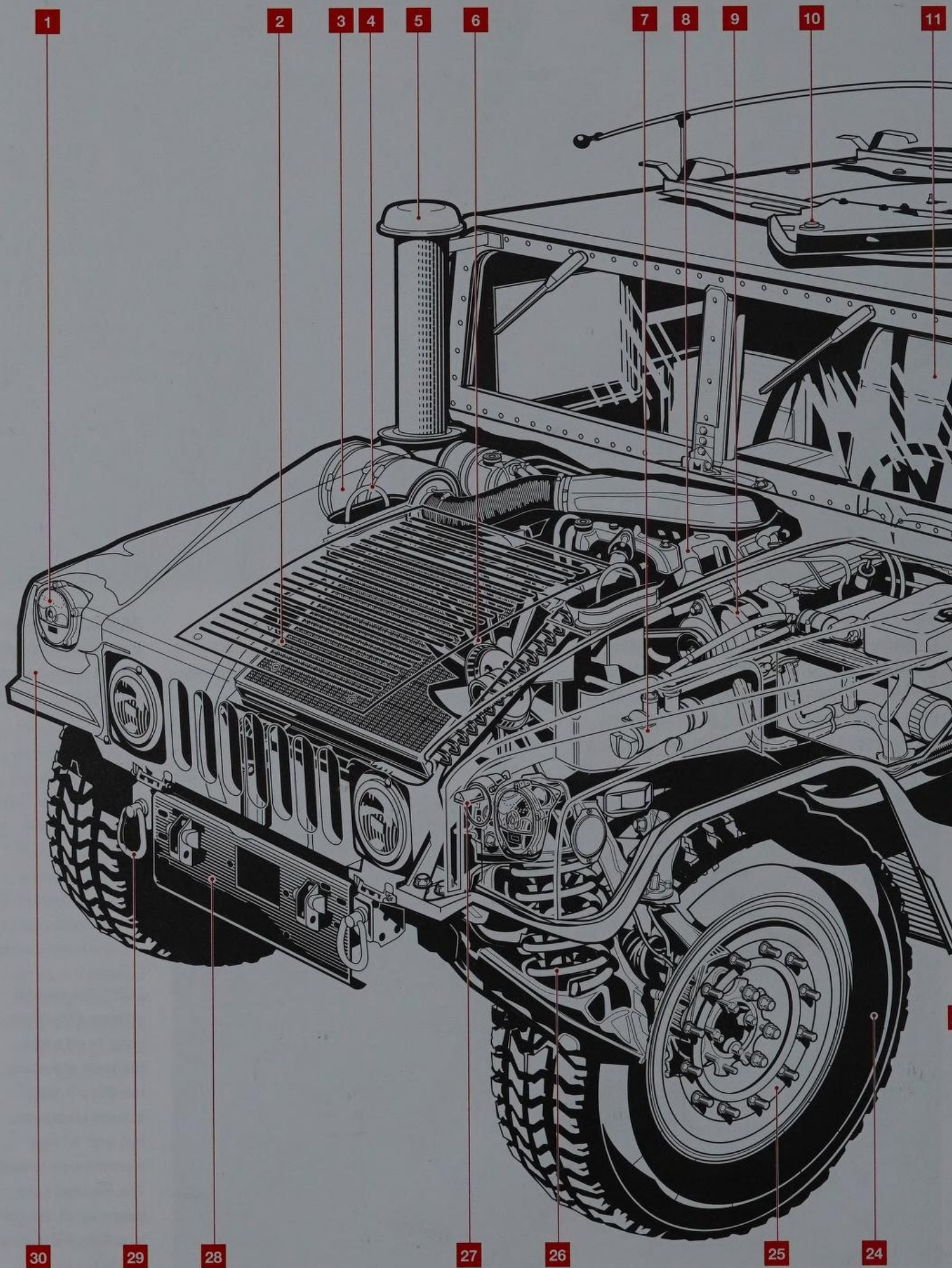
made for mounting a winch behind the front bumper. Rear bumpers and a towing pintle are attached to the rearmost cross-member; US Marine Corps vehicles are not fitted with the rear bumpers in order to provide a small improvement in the departure angle. The engine is mounted towards the front of the chassis, set back behind the front axle, and positioned at a slight angle to provide clearance for the front driveshaft. The transmission is coupled directly to the torque-converter housing.

Tie-down and lifting eyes are provided in strategic positions to allow shipment by air, rail or sea.

ABOVE Rear three-quarter view of the M1038 cargo/troop carrier. *(David Doyle)*



LEFT The narrow chassis allows the body to straddle the main members, resulting in high ground clearance, but with a huge transmission tunnel. The members are swept up at the front to cradle the engine. *(David Doyle)*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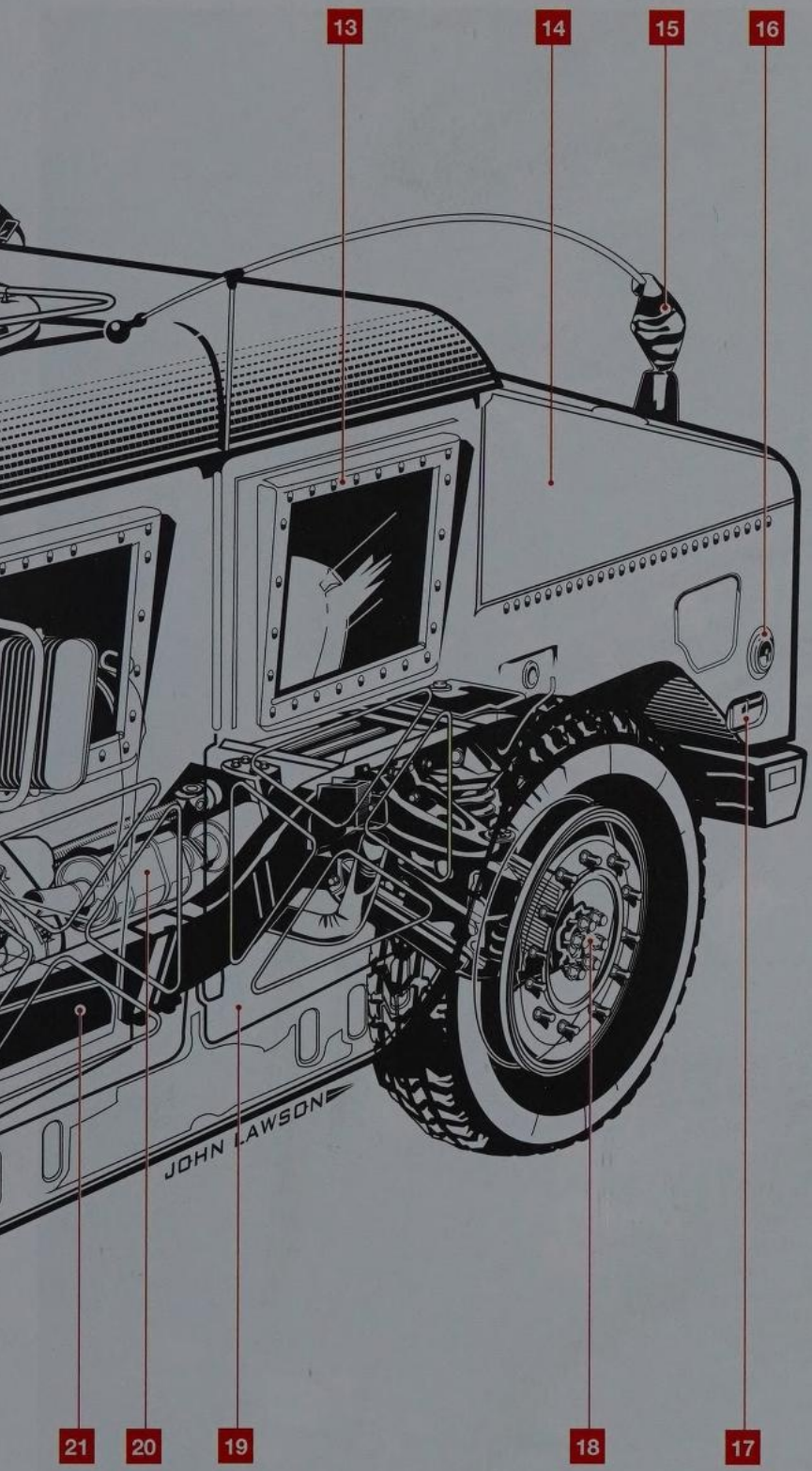


Cutaway drawing shows winch-equipped M1026 armaments carrier with factory-fitted 'basic armour'. *(John Lawson)*

1 Combined turn indicator and blackout marker light
2 Radiator and oil cooler
3 Air filter
4 Loop for attaching helicopter sling
5 Raised air intake for deep-water wading
6 Clutch-driven cooling fan
7 Brake master cylinder
8 6,227cc (later 6,555cc) V8 diesel engine
9 60Ah, 100Ah or 200Ah 24V alternator
10 Location for machine-gun pedestal mount
11 2in (51mm) thick polycarbonate windscreen
12 Roof hatch cover
13 Polycarbonate sliding window
14 Top/bottom-hinged hatch to cargo area
15 Antenna and mount
16 Side reflector
17 Side position marker light
18 Geared hub
19 Kevlar-reinforced door
20 Exhaust silencer (muffler)
21 Double-drop tapered ladder chassis of electrophoretically-coated steel
22 Three-speed (later four-speed) automatic transmission
23 Windscreen washer reservoir
24 16.5in bias-belted or radial run-flat tyre
25 Two-piece 16.5in steel disc wheel with magnesium or rubber run-flat insert
26 Independent suspension using twin A-arms, coil springs, and telescopic double-acting hydraulic shock absorbers
27 Blackout driving light
28 Electrically-driven 6,000 lb (2,727kg) winch mounted behind crossmember
29 Tie-down shackle
30 Glass-fibre composite hinged engine cover

RIGHT The engine is mounted at the front of the chassis, set back behind the front axle, and positioned at a slight angle to provide clearance for the front driveshaft. This allows the radiator to be set at an angle to reduce the height, but also results in the rearmost cylinders being virtually inaccessible. *(Phil Royal)*

Engine

The engine fitted to the original M998 series was designed by General Motors and produced by the company's Detroit Diesel Allison Division. Originally introduced for the GM (Chevrolet) C/K range of pickup trucks in 1982, it is a commercial V8 water-cooled normally aspirated diesel with a capacity of 6,217cc (379.4cu in), and is basically the same type of engine as that fitted to the US Army's Chevrolet-derived CUCV (commercial utility cargo vehicle) series.

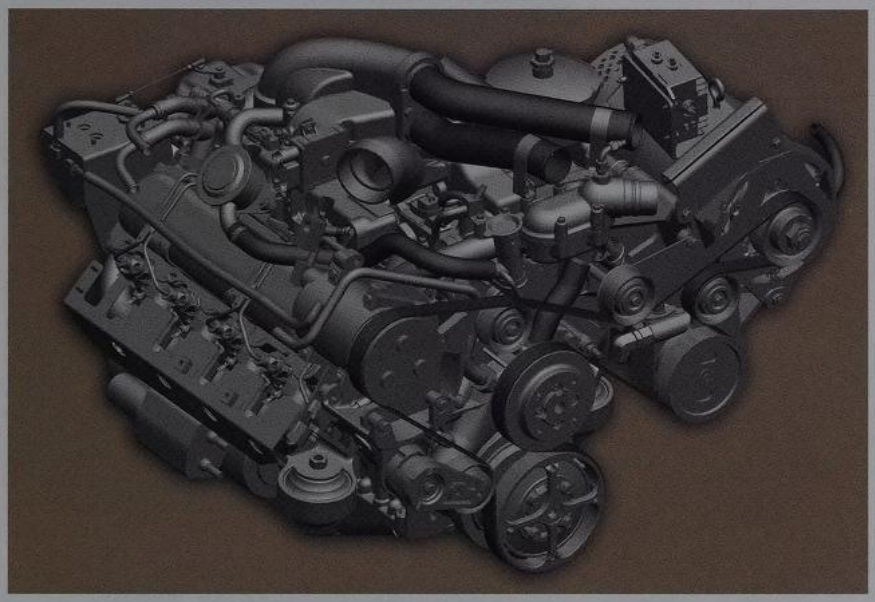
Bore and stroke measure up at 3.98in (101mm) and 3.82in (97mm) respectively, and the cylinder banks are arranged at 90°, topped by cast-iron cylinder heads: the one-piece crankcase is also constructed from cast iron and the complete engine weighs 650lb (295kg). Standard compression ratio is 21.3:1. The crankshaft runs in five main bearings, with a torsional damper fitted at the nose end, and there are two valves per cylinder, mounted side by side, and operated by hydraulic roller-type lifters and pushrods via pressed-steel rockers. Glow plugs are installed in the heads to aid cold starting, and emissions control is achieved by a combination of positive crankcase ventilation and a catalytic converter.

When compared to the original commercial version of this engine, a different design of injector pump allows the power output to be increased to 150bhp at 2,000rpm.

From 1990 various modifications were introduced to the engine to improve performance, increase durability and reduce emissions. Some of the modified parts are not interchangeable with those fitted to earlier engines, and there may be some differences in routine maintenance procedures.

As part of the upgrades associated with the improved 'A2' series, the original 6.2-litre engine was superseded by a 6.5-litre unit, which was subsequently constructed by AM General's subsidiary, General Engine Products (GEP). The increased capacity (6,555cc, 395cu in) was achieved by boring out to 4.06in (103mm), and this had the effect of upping the power output to 160bhp. The 6.5-litre engine is identified by a serial number barcode decal.

From 1995 the so-called 'expanded capacity vehicle' (ECV) was fitted with a redesigned, turbocharged version of the 6.5-litre engine, using a Caterpillar ADEM III electronic controller. Described as the Optimizer 6500 engine, the design changes provide a 20–25 per cent increase in the tensile strength of the engine block by using high-strength molybdenum-steel, combined with taller and wider bearing caps and improved head-bolt bosses. Vehicles fitted with this power unit can be quickly identified by the protruding grille necessary to accommodate the turbocharger. These changes provide a 36 per cent increase in power, to a maximum of 190bhp at 3,400rpm, coupled with a 69 per cent increase in torque, better acceleration and improved range. Although the weight of the engine has increased to 756lb (344kg), the dimensional envelope remains virtually unchanged, meaning that the engine is also suitable for simple retrofitting to existing Humvees.



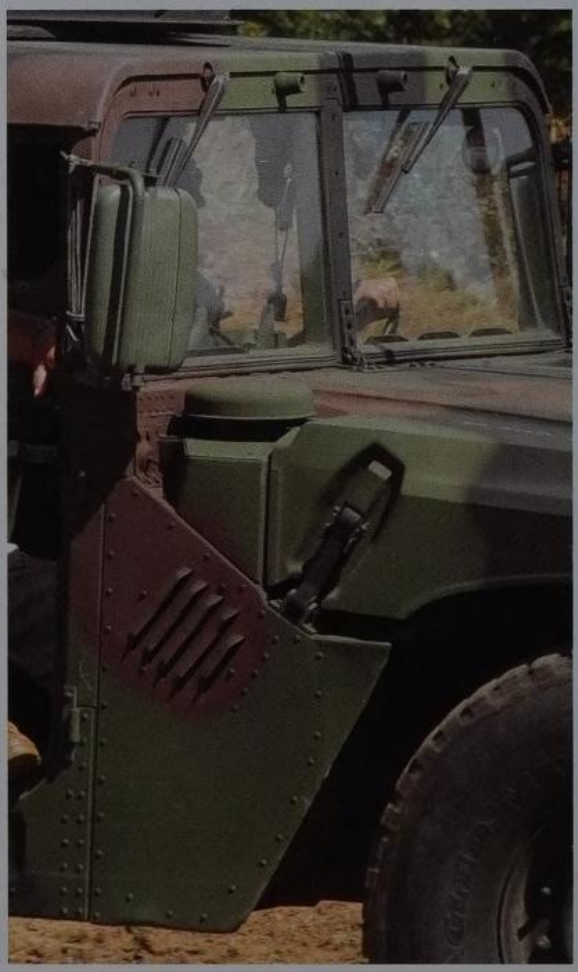
ABOVE Computer-generated rendering of the Optimizer 6500 engine that replaced the original 6.2-litre unit, viewed from the front end. *(AM General)*

BELOW From 1995, the so-called 'expanded capacity vehicle' (ECV) was fitted with a redesigned, turbocharged version of the 6.5-litre engine. The design changes provide a 20–25 per cent increase in the tensile strength of the engine block. *(David Doyle)*

RIGHT The fuel filler is located on the right-hand side of the vehicle behind the rear door opening. *(Phil Royal)*

Fuel system

All Humvees are diesel-engined, and are designed to run on diesel fuel 'number 1' (1-D or DF1, cetane rating of 44 or 45) in ambient temperatures of 10°F to -20°F (-12°C to -29°C), or diesel fuel 'number 2' (2-D or DF2, cetane rating of 40) in temperatures above 10°F (-12°C). In extreme cold (temperatures below -20°F (-29°C)), US Army documentation suggests that 'diesel fuel arctic' (DFA) should be used.



RIGHT The engine air intake is located at the right-hand rear corner of the engine compartment. The photograph shows the standard, low-level intake. *(Phil Royal)*

The fuel system comprises a blow-moulded polypropylene fuel tank with a capacity of 25 US gallons (20.7 Imperial gallons, 95 litres), filters and separators, a lift pump and the engine fuel-injection equipment.

The fuel tank is located at the extreme rear of the vehicle, on the right-hand side between the chassis rails. A gauge on the instrument panel indicates the level of fuel in the tank. The fuel-injection pump is of the diaphragm type, and is mounted on the top of the engine, under the intake manifold, and is driven by a gear on the camshaft. Fuel is supplied to the injection pump, via a combined filter and water separator, by a cam-driven mechanical diaphragm-type pump installed on the left-hand side of the engine. The injectors are designed to operate at a pressure of around 1,950lbf/in² (1.37kgf/mm²).

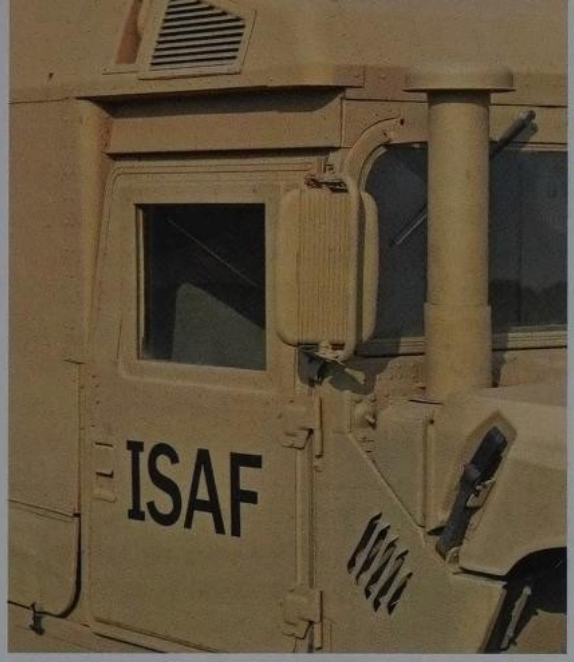
Lubrication system

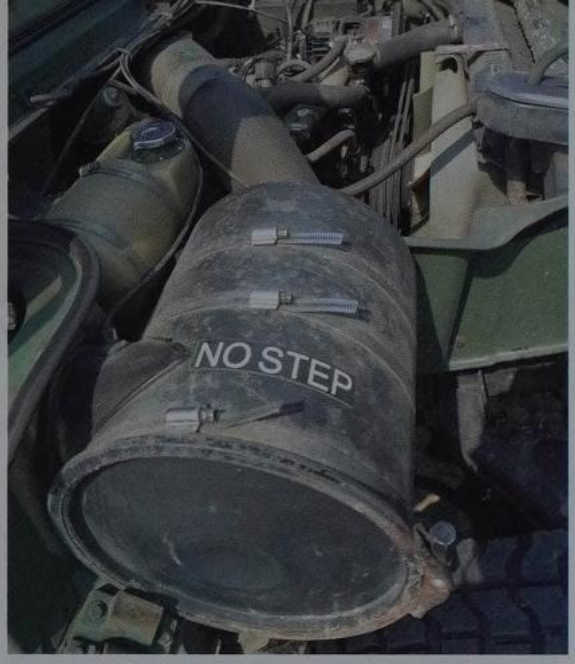
The engine lubrication system consists of a gear-driven pressure pump, providing a maximum oil pressure of 40–50lbf/in² (2.8–3.4kgf/cm²); at idling speed, the pressure will drop to 15–20lbf/in² (1–1.4kgf/cm²). Oil is drawn from a conventional wet sump, through the oil cooler, and is then passed through a standard military cartridge-type full-flow filter, and thence to the various oil galleries. A spring-loaded bypass valve protects the engine from oil starvation in the event of the filter becoming blocked. The oil-pressure gauge is operated by a transducer at the rear of the cylinder block on the left-hand side, reading the pressure from the left-hand main gallery.

The capacity of the lubrication system, including the filter, is 1 US gallon (0.83 Imperial gallons, 3.8 litres).

Intake system

The intake system comprises the raised air-entry stack, to which is fitted a rain cap, a paper filter element, air-filter canister, ductwork and the engine inlet system. Combustion air is drawn through the stack and the filter, where impurities such as dust and grit are removed, and thence to the inlet manifold via the manifold ductwork. A restriction sensor in the ducting records the amount of dust in the air, displaying this on the air-restriction gauge on the





FAR LEFT **Those vehicles equipped for deep-water wading are fitted with a high-level air-intake system, allowing immersion to a depth of 60in (1,525mm).** *(Phil Royal)*

LEFT **The air filter assembly is located close to the intake and is connected to the engine via rubber trunking.** *(Simon Thomson)*

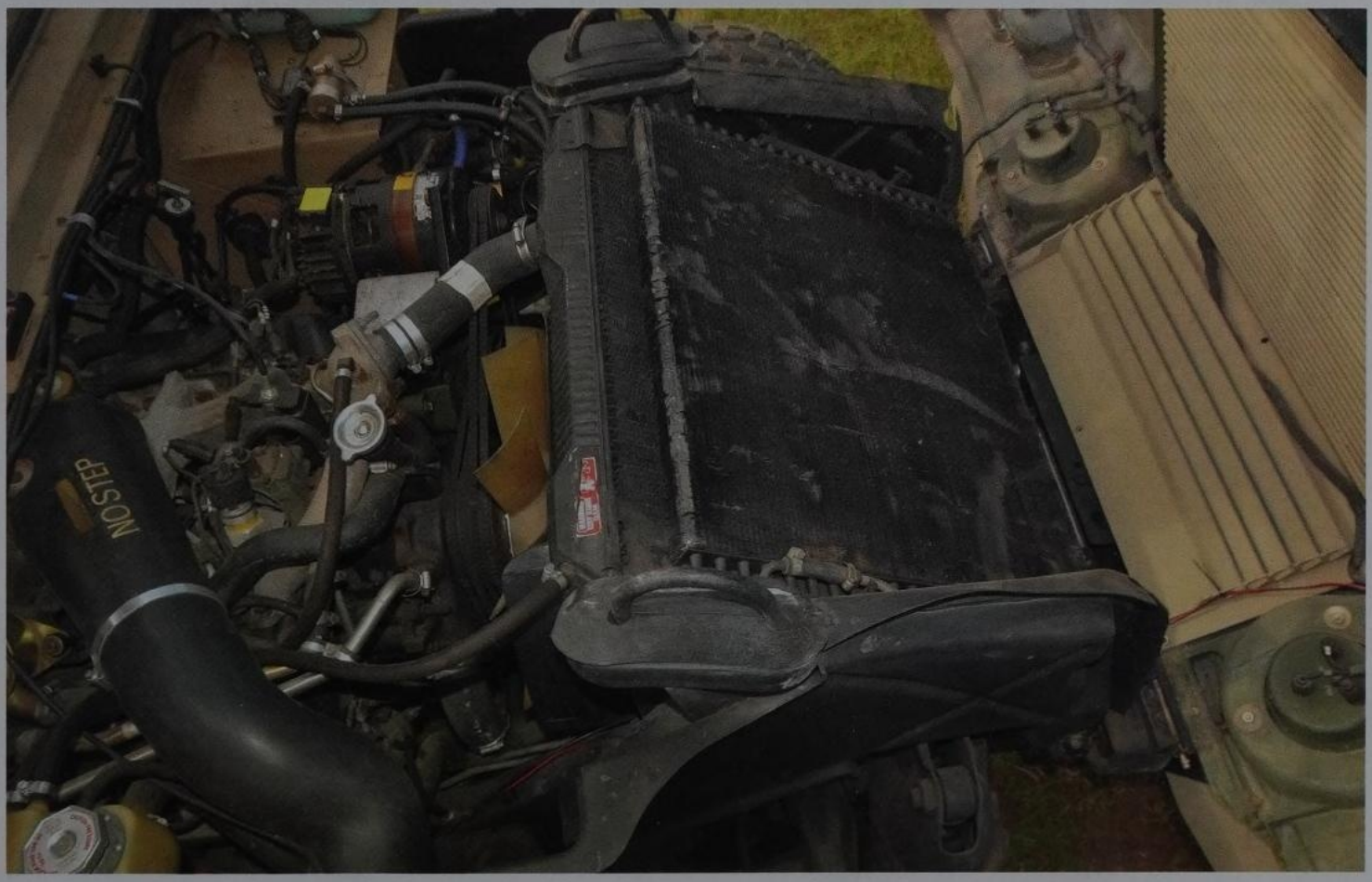
BELOW **In order to keep the frontal height to a minimum, the radiator is inclined back towards the engine, with the oil cooler laying on top of it.** *(Phil Royal)*

instrument panel, thus indicating when the filter element needs to be cleaned or renewed.

Cooling system

The engine is maintained at optimum working temperature by means of a conventional sealed and pressurised cooling system with a capacity of 3.25 US gallons (2.7 Imperial gallons, 12.25 litres), comprising a down-flow radiator, surge tank, thermostat, ten-blade plastic fan and drive clutch, water pump and various drive belts. The normal operating temperature for the engine is between 190°F and 230°F (88°C and 110°C), with the thermostat opening at 190°F (88°C). The fan-drive clutch engages when a sensor in the water crossover tube reads 230°F (110°C), disengaging it at the lower temperature of the operating range. If the fan clutch fails, it is possible to manually override the thermostat.

An optional 'solid' fan-drive system can be fitted for operation in extreme temperature conditions.



RIGHT The standard exhaust system exits in front of the left-hand rear wheel, but an optional raised exhaust system is also available using a vertical extension to the pipe to allow deep-water wading. *(Phil Royal)*

BELOW The transmission is coupled directly to the rear of the engine by means of a three-element torque converter. The way that the body is designed to straddle the transmission results in this huge transmission tunnel. *(David Doyle)*

Exhaust system

The exhaust system consists of a manifold bolted to the outer face of each cylinder head, with a crossover tube connecting the manifolds; the silencer is of reverse-flow double-pass design and is mounted between the chassis rails ahead of the rear axle. The tail pipe exits in front of the left-hand rear wheel, but an optional raised exhaust system is also available using a vertical extension to the pipe.

The manifolds are cast from nodular iron, and the other components of the exhaust system are fabricated from stainless steel and aluminised steel in order to reduce corrosion.

Transmission

All Humvee variants feature permanent four-wheel drive with a centre differential and locking axles front and rear. A cooler for the transmission oil is mounted alongside the radiator and the transmission is vented into the intake system to prevent water being drawn in during wading operations.

In the original M998 and M998A1 series, the transmission is coupled to the engine via a three-element torque converter, with a ratio of 1.96:1. The gearbox is a General Motors 3L80 three-speed automatic unit – a version of the standard commercial GM THM-400 Turbo Hydra-Matic. Selector positions are 'reverse' (R), 'neutral' (N), 'drive' (D), 'second' (2), and 'first' (1), with a standard manual selector and kick-down switch. The kick-down has the effect of forcing the transmission to change down one gear range lower than that selected on the shift lever. There is no 'park' position. Gear ratios are 2.48:1, 1.48:1 and 1:1, with 2.08:1 for reverse.

BELOW View of the shift lever for the main transmission, and the transfer-case selector lever. Note the lack of a 'park' position on the transmission selector, an identifying feature of the early THM-400 Turbo Hydra-Matic automatic gearbox. *(David Doyle)*

Late-production 'A1', and all 'A2' and 'A3' variants, are fitted with a four-speed electronically controlled GM 4L80E transmission, lacking the kick-down facility; the first three gear ratios are unchanged, but there is an overdrive top gear with a ratio of 0.75:1; this transmission unit does include a 'park' position. A warning light on the instrument panel indicates if there are problems with the transmission.

A chain-driven NP218 or NP242 (M1097 and later variants) two-speed locking transfer case is fitted to the rear of the transmission. The transfer case was originally constructed by Chrysler Corporation's New Process Gear Company, but in 1990 this became part of the jointly owned New Venture Gear Company, in which General Motors and Chrysler both held a stake and for which production took place at the GM Muncie plant. In 2010 New Venture was taken over by Magna Powertrain.

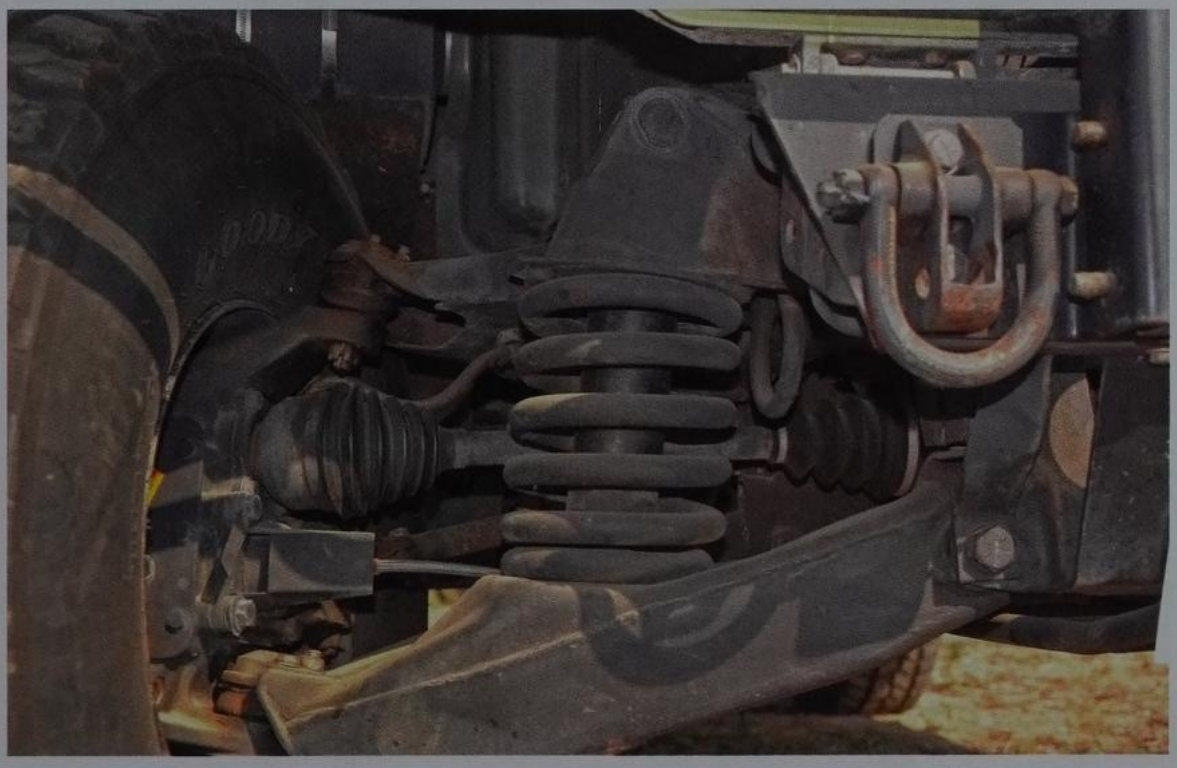
Both transfer cases incorporate a centre differential and an oil cooler, but the NP242 is fitted with planetary gears rather than the bevel gears of the earlier version. The transfer case operating lever is to the left of the main transmission selector, and the positions include 'high' (H), 'high lock' (HL), in which the centre differential is locked out, 'neutral' (N) and 'low' (L). The reduction ratio, when the transfer case is in low range, is 2.61:1 (NP218) or 2.72:1 (NP242).

The drive is conveyed to the front and rear differentials by conventional propeller shafts, with the front shaft fitted with double Cardan joints. Changes made to the 'A1' variants and later included upgraded propeller shafts with heavy-duty Cardan joints.

Axles and suspension

Supplied by Gleason Power Systems, the frame-mounted hypoid axle differentials are of the Torsen torque-biasing pattern, and are identical front and rear; a locking feature is operated by the driver simply by means of the brake pedal. Mounted high in the chassis on a suspended carrier fitted between the chassis rails, the differentials help to provide the maximum ground clearance, and short driveshafts convey the power to the hubs via a vertical gear train. Reliability-enhanced 'A3' variants incorporate a cooler in the rear differential.

The differential ratio was originally 2.56:1, but for the 'A1' and later variants the gears were modified to give a ratio of 2.73:1. The hub reduction ratio is 1.92:1, and the use of a gear train as opposed to the more normal planetary gear system, again, helps to ensure that the maximum 16in (400mm) ground clearance can



LEFT Under-chassis view showing the right-hand front suspension assembly and the driveshaft. The driveshaft enters the hub above the centreline of the wheel, with the power transferred via a reduction gear train. *(Phil Royal)*

LEFT Under-chassis view from the rear showing the differential guard, suspension arrangements and driveshaft. It is also possible to see components of the pioneer kit that are stowed under the chassis at the rear. *(Phil Royal)*

be maintained, as well as doubling the torque available at the wheels.

Independent suspension is provided at both front and rear, using parallel A-configuration ball-jointed control arms, with open-ended coil springs; the A-arms are identical front to rear, but a radius rod, or sway bar, is installed at the front, connecting the lower control arm to the chassis via a pivot bracket. Heavy-duty suspension is fitted to the shelter-carrier variants. The springs enclose a large telescopic double-acting hydraulic shock absorber.

On 'A1' and later variants there are upgraded halfshafts, front and rear, and variable-rate rear springs, whilst for the 'A2' and 'A3' variants the upper control arms were of improved design, with a new type of bushing adopted for the 'A3'.

Steering

The steering is power-assisted, using a Saginaw 708 variable ratio (13/16:1) integral unit that offers a considerable degree of precision, with a minimum turning radius of 25ft (7.625m) in either direction, measured between

ABOVE And this is what happens to the suspension when a Humvee drives over an anti-tank mine! Note how the driveshaft has been pulled out of the differential casing and the lower control arm joint has been destroyed. *(US Department of Defense)*

RIGHT View of the rear hub and suspension arrangement with the wheel removed. *(David Doyle)*

BELOW The inclusion of power-assisted steering as standard allows the use of a relatively small steering wheel – just 14in (355mm) in diameter. *(Phil Royal)*

walls. An oil cooler is fitted between the power-steering pump and the steering gear.

Directional control is maintained via a three-spoke 14in (355mm) diameter steering wheel of black composite material. The steering wheel and column were modified for the 'A2' and later variants, and a new steering pump was subsequently introduced. A steering-wheel lock cable permits the wheel to be locked to prevent unauthorised use.

Brakes

Inboard hydraulic disc brakes are fitted at all four wheels, with a disc diameter of 10.5in (267mm) giving an effective braking area of 17.4in² (0.011m²) for each wheel. The master cylinder is of the dual-reservoir design and includes a power-boost feature; military-grade silicone brake fluid is used as standard. A mechanical parking brake operates manually on the rear discs.

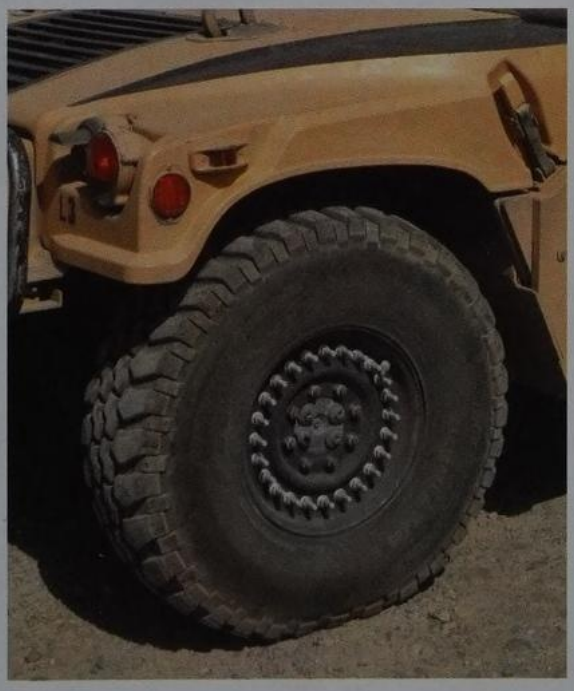
The disc brake pads were of improved design on the 'A1' and later variants, and for the 'A2' and subsequent vehicles the discs were increased to 12in (305mm) diameter.

Wheels and tyres

The wheel and tyre equipment consists of two-piece 16.5in (420mm) steel disc wheels attached to the hub by eight bolts, with eight bolts similarly used to secure the flanges. The number of flange bolts was subsequently increased to 12 and then, when the M1100 series was introduced, 24-bolt wheels were fitted.

The tyres fitted to these wheels were originally 37-12.50 16.5in Goodyear Wrangler R/T-II bias-belted run-flats with cast magnesium-alloy run-flat bead-lock inserts, designed to allow a vehicle to run on a

ABOVE The Humvee rides on two-piece steel wheels, 16.5in (420mm) in diameter, wearing 37-12.5R 16.5in Goodyear Wrangler R/T-II bias-belted run-flat tyres. The wheels are secured to the hub by eight bolts, and the two parts of the original wheels were also bolted together using eight bolts. *(Jeff Symanski)*



FAR LEFT Later wheels used 12 bolts to secure the two flanges, and were generally shod with Goodyear MT radial run-flat tyres. *(Simon Thomson)*

LEFT When the M1100 series was introduced, a change was made to 24-bolt wheels. The tyres on this Mongolian Army vehicle are B.F. Goodrich Baja T/A radial run-flats. *(Carl Schulze)*

RIGHT The original run-flat bead-lock insert was made from cast magnesium-alloy and allowed a vehicle to run on a deflated tyre for around 30 miles (50km). When the A2 upgrade appeared in 1995, rubber bead-lock inserts were adopted to provide greater mileage when running on deflated tyres. *(Jim Alexander)*

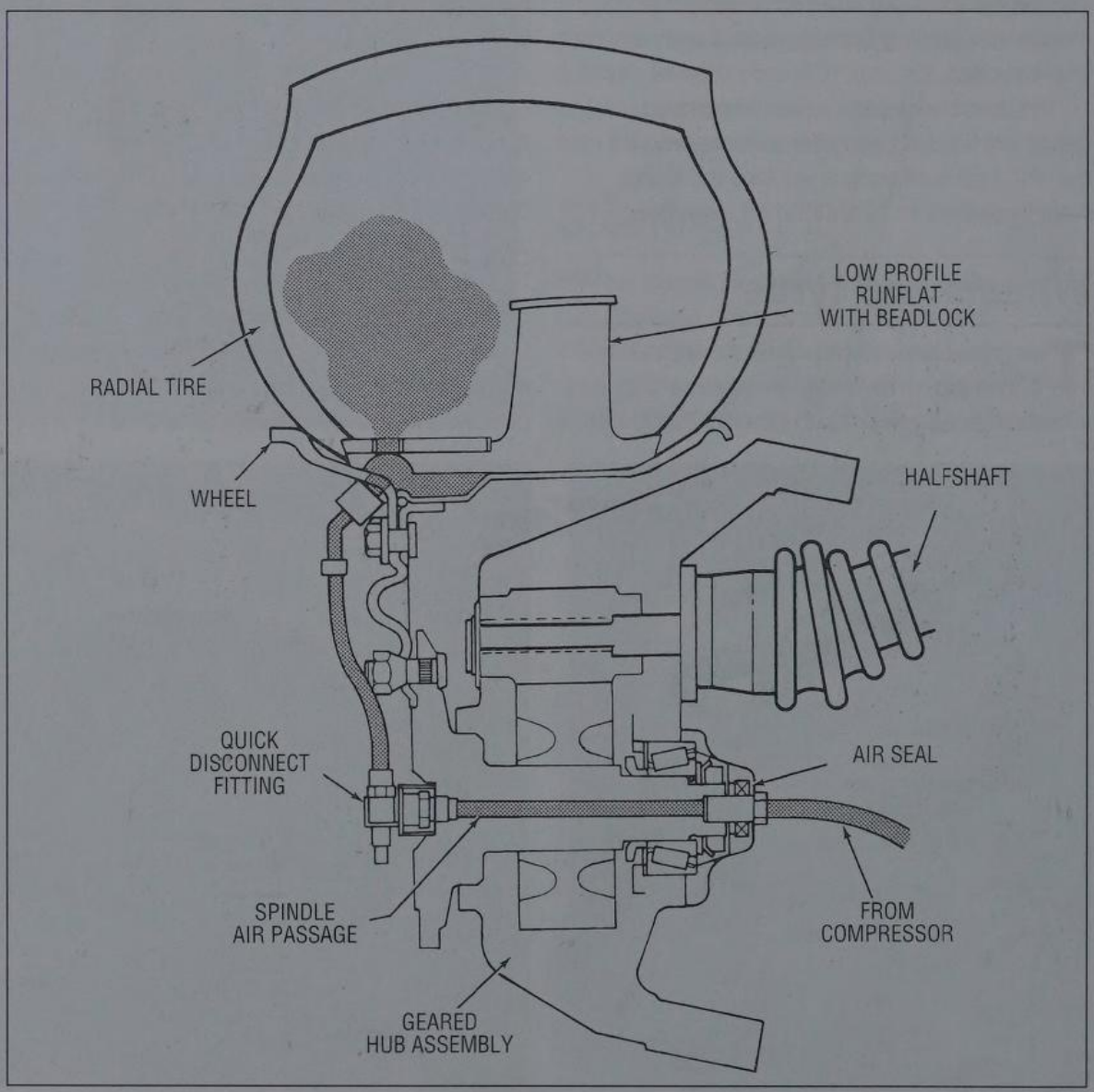
deflated tyre for around 30 miles (50km). With the appearance of the 'A2' variant in 1995 a change was made to rubber bead-lock inserts that provided greater mileage when running on deflated tyres.

In the early 1990s radial tyres were adopted in place of the original bias-belted design, and the tyre specification was changed to 37-12.50R Goodyear MT run-flat radials. Mickey Thomson Super Swamper tyres have also been used, and these apparently offer improved road mileage.

A tyre-pressure monitoring system is provided on the 'A2' and later variants, with tyre pressures displayed to the driver via a small illuminated display on the transmission tunnel.

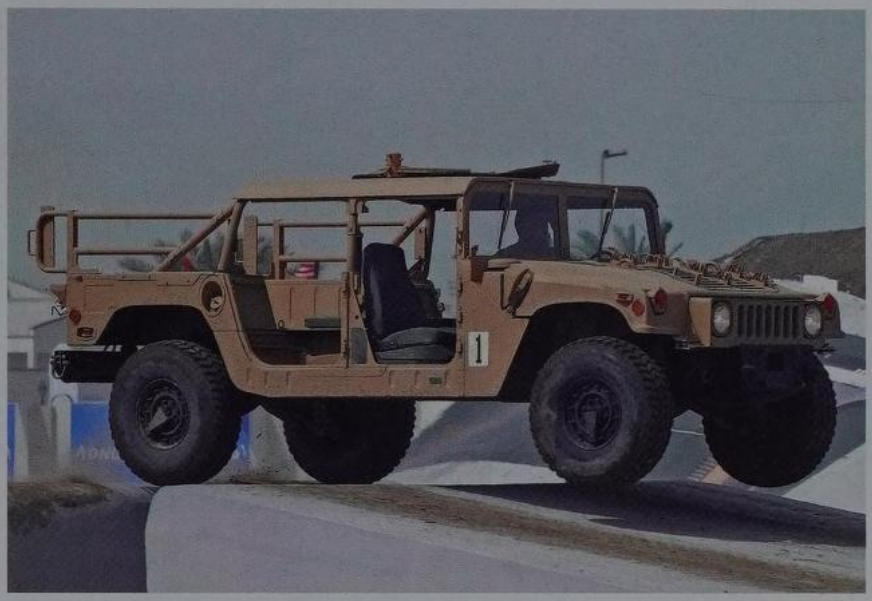
Central tyre-inflation system

An optional central tyre-inflation system (CTIS) is available that allows the driver to monitor and adjust the tyre pressures on the move from inside the vehicle. An electric compressor provides the



RIGHT The central tyre-inflation system (CTIS) allows the driver to adjust the tyre pressures on the move, from inside the cab. An electric compressor provides the air supply, with a selector panel allowing either the front tyres, the rear tyres or all four tyres to be inflated or deflated. *(AM General)*

RIGHT Vehicles fitted with the CTIS can be recognised by the small, flat protective guards fitted over the pipework that runs from the hub to the tyre valve. *(Simon Thomson)*



necessary air supply, and a small selector panel allows either the front tyres, the rear tyres or all four tyres to be inflated or deflated within the range 5lbf/in² to 40lbf/in² (0.35kg/cm² to 2.81kg/cm²). The deflation time for all tyres from 35lbf/in² to 6lbf/in² (2.46kg/cm² to 0.42kg/cm²) is less than two minutes; inflation time across the same range is around 14 minutes.

The design of the CTIS was improved with the appearance of the 'A2' variant.

Winch

The original standard winch option was an electrically driven Warn unit, rated at 6,000lb (2,727kg); as the weight of the Humvee increased, this was subsequently superseded by a Warn Mil-9000 unit, rated at 9,000lb (4,090kg). On later production vehicles a hydraulic winch was used, driven by the power-steering pump.

Electrical system

The vehicle is wired on a (nominal) 24V system, with two 12V batteries fitted in an enclosed compartment under the right-hand (companion) front seat.

The major components of the electrical system consist of the alternator, with 60Ah, 100Ah or 200Ah machines fitted according to the vehicle's role, the starter motor, four-part wiring harness, protective control box, thermal circuit breakers on a panel below the dashboard, instruments and gauges, lighting system, indicators, horn, two-speed windscreen wash/wipe system and the fresh-air heater and defroster. Early examples, at least, did not require a key for starting. 'A2' and later variants have a dual-voltage 14V/28V alternator, and there are also connection points for radio equipment, as well as receptacles for a standard NATO inter-vehicle slave cable, on the face of the battery box, and a trailer cable at the rear.

All electrical equipment is proofed to allow operation when submerged in either fresh or salt water. When the deep-water fording kit is fitted, a switch allows the operator to select 'vent' position for normal running, or the 'deep ford' position for deep-water fording.

A connection point at the front end of the transmission tunnel allows the use of the military 'simplified test equipment, internal combustion engine, reprogrammable' (STE/ICE-R) diagnostic test meter to interrogate stored engine system fault codes.

Instruments

A removable instrument cluster in the driving compartment includes gauges for engine temperature, oil pressure, fuel level, battery voltage and vehicle speed; an air restriction gauge indicates when the engine air cleaner

BELOW 'A0' and 'A1' variants that were fitted with a winch were identified using separate numbers; this practice was discontinued when the 'A2' upgrade was introduced, and the winch became an option. On early examples, the winch – which was manufactured by Warn – was electrically driven; on later models a hydraulic winch was used. *(David Doyle)*

LEFT The instrument panel is a standard military unit and includes gauges for engine temperature, oil pressure, fuel level, battery voltage and vehicle speed; late models are also fitted with a rev counter (tachometer). A separate air restriction gauge indicates when the engine air cleaner needs attention. *(Jeff Symanski)*

needs attention. Late models are fitted with a rev counter (tachometer).

The main rotary switch has 'engine stop', 'run', and 'start' positions, and warning lights are provided for the operation of the engine glow plugs ('wait to start'), headlamp main beams and braking system. The brake system warning light indicates that there is a hydraulic failure that would result in an imbalance between the front and rear braking systems, as well as warning that the parking brake is engaged.

Lighting equipment

The Humvee is fitted with a standard US military lighting system consisting of standard (service) lights for normal road use and a blackout system, with individual circuits protected by thermal trip units. 'A2' and later versions have LED side marker lights and some vehicles supplied to overseas customers also include additional white marker lights at the front.

A locking rotary switch controls the headlamps, the blackout running lights, the blackout driving light, the panel lights and the turn indicators and side repeaters; later variants were fitted with a push-button switch of similar shape and size. When the switch is in the

RIGHT The front lighting arrangements include a pair of headlights, turn indicators (and side repeaters), blackout running lights and a blackout driving light. Reflective markers indicate the extremities of the vehicle. *(Simon Thomson)*

RIGHT At the rear there are running lights, indicators and side repeaters, brake lights and blackout running lights. Reflectors mark the rear and side of the vehicle. *(US Department of Defense)*

BELOW The original lighting switch used three interlocked rotary levers to select the various lighting options. This switch unit was also used in many other US military vehicles. *(Jim Alexander)*

'blackout' position, the standard road lighting equipment does not operate.

The turn indicators are controlled by a solid-state electronic flasher unit that also provides a hazard flashing sequence.

Photographs show that many Humvees in service are fitted with additional lighting equipment, including convoy warning strobe lights, infrared lamps, flexible hand lamps and additional front- or turret-mounted spotlights.

Air-conditioning equipment

The interiors of up-armoured variants operated under extreme climate conditions can reach a temperature of more than 130°F (54°C), and since April 2004 around 10,000 vehicles for use in these conditions have been retrofitted with roof-mounted Red Dot air conditioners capable of reducing the internal temperature by around 45°F (25°C).

Air-conditioning equipment can also be factory fitted.

Bodywork

All soft-skin Humvee variants share the same basic body configuration, consisting of a full-width front-hinged glass-fibre composite engine cover, press-moulded in two parts, a scuttle and 'A' pillar assembly, which carries the folding (and removable) two-light windscreen,

LEFT Later vehicles were fitted with a push-button lighting switch designed to fit into the same aperture. The turn indicator and hazard-warning switch can be seen to the right of the lighting switch. *(Phil Royal)*

and skeleton aluminium-alloy body panels. An integral hoop connects the 'B' pillars on either side of the vehicle, and the windscreen frame is also sufficiently strong to act as a roll-over bar. The original air-inlet grille in the engine cover included eight slots, but from the 'A1' upgrade onwards this was modified to include more slots to provide additional cooling air; earlier vehicles were frequently upgraded with the new grille.

The body panels, which are pressed from 6010 grade heat-treatable magnesium-silicon aluminium alloy, are riveted and bonded to extruded support beams in such a way as to provide maximum structural strength whilst still being able to flex sufficiently to accommodate off-road stresses. The enclosed bodies of the

LEFT Air-conditioning units have always been available as an option, but all of the M1114 up-armoured variants are fitted with air conditioning as standard in order to allow the enclosed vehicle to be operated in desert conditions. The grilles in the rear of the armoured slant back give the game away. *(US Department of Defense)*

RIGHT All softskin Humvee variants share the same basic body configuration, with a full-width front-hinged composite engine cover, a scuttle and 'A' pillar assembly, which carries the folding/removable windscreen, and skeleton aluminium-alloy body panels. An integral hoop connects the 'B' pillars, whilst the windscreen frame is also sufficiently strong to act as a roll-over bar. Other body panels are fitted according to the vehicle's role. *(AM General)*

ABOVE On early examples, the air-inlet grille in the engine cover had eight slots, but from the 'A1' upgrade onwards this was modified to include more, and narrower, slots to provide additional cooling air; earlier vehicles were frequently upgraded with the new grille. The distinctive frontal appearance is partly down to the seven-slot radiator grille panel. *(Phil Royal)*

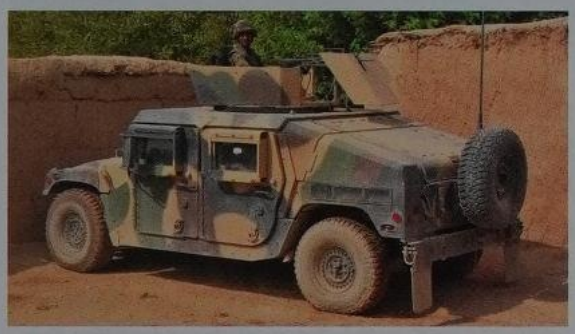
ABOVE M1038 winch-equipped four-door cargo/troop carrier that has been fitted with Kevlar-protected doors and a hard roof panel. Note the low cover over the cargo bed. *(Simon Thomson)*

BELOW M998 cargo/troop carrier in two-door configuration, with soft doors and a high cover to the cargo area. The vehicle, which belongs to the 3rd Brigade, 2nd Infantry Division out of Fort Lewis, Washington, was photographed at the Port of Pusan in South Korea. *(US Department of Defense)*

BELOW M998 cargo/troop carrier of the US Marine Corps. Operating with the US Navy as part of 'landing force co-operation afloat readiness and training', the vehicle is configured with four soft doors, and fitted with deep-water wading equipment. *(US Department of Defense)*

RIGHT M1097A2 heavy variant cargo/troop carrier with a hardtop cab and rear-door infill panels. Although the vehicle has the high-level air intake, it has not been fitted with the corresponding high-level exhaust system. *(Simon Thomson)*

BELOW M1151A1 expanded capacity IAP-ready armament carrier of the Afghan Army fitted with the B1 kit and 'frag kit 5'. *(Carl Schulze)*



RIGHT The box-body that provides the rear accommodation for the M997 maxi-ambulance can also be used in the so-called 'C3I' role (command, control, communications, intelligence), as in this United Arab Emirates vehicle photographed in Kosovo in 1999. *(Carl Schulze)*

'mini' and 'maxi' hardtop ambulances consist of a one-inch (25mm) layer of polyurethane foam with a thin outer face of aluminium alloy. The walls and roof of the body are lined with Kevlar, a resin-bonded composite consisting of woven organic aramid fibre, to provide a measure of protection against shrapnel.

Except on certain specialised variants, the tailgate – which on early examples was pressed with the legend 'AM General' – is bottom-hinged and can be supported in a horizontal position on chains to provide an extension to the load bed. Footman loops are fitted to allow a camouflage net to be strapped to the outer face of the closed tailgate.

RIGHT The one-piece press-moulded engine cover tilts forward to provide access to the engine. In the opened position the cover also prevents the vehicle being spotted by reflections from the windshield. Note how the brush guard is separately hinged. *(Simon Thomson)*

RIGHT Inside view of the engine cover showing the reinforced twin-skin construction. *(Phil Royal)*

FAR RIGHT Early production vehicles featured the manufacturer's name pressed into the tailgate. *(Phil Royal)*

LEFT Rear view showing the bottom-hinged tailgate. Being an ex-Marine Corps vehicle, this M998 does not have the rear bumpers. *(David Doyle)*

BELOW LEFT In the dropped-down position the tailgate is supported by stout chains and can be used as a load platform – clearly it can withstand considerable abuse! *(US Department of Defense)*

BELOW Additional footman loops can be attached to the tailgate to accept webbing straps. This vehicle was photographed during 'Operation Ten Bears' in Zafaraniyah, Baghdad, in January 2006. Note the extended rear cross-member onto which the towing pintle has been attached. *(US Department of Defense)*

FAR LEFT Bagged camouflage netting stowed on the tailgate. *(Jim Alexander)*

LEFT The body of the maxi-ambulance is extended beyond the rear cross-member; the overhang provides space for a stowage locker and a set of fold-up steps. *(David Doyle)*

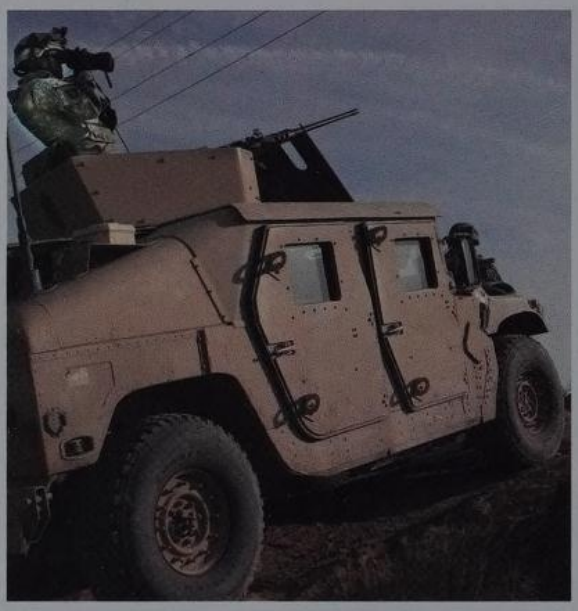
Kevlar composite is also used for the front-hinged doors, which have a distinctive X pattern moulded into the panel to provide some rigidity, and include vertically sliding polycarbonate glazing. These Kevlar doors can also be fitted to other variants in place of the standard doors, which consist of vinyl-coated cloth on a steel frame, with transparent inserts. Two-door variants are fitted with removable aluminium panels to blank off the rear door apertures. Rigid thermal-insulation material is applied to the floor and to the transmission tunnel.

Most vehicles are supplied with a removable

BELOW Early M1043 showing the doors that are fitted to vehicles equipped with the supplemental armour. Photographed at Miramar Naval Air Station, California, in 2007, the vehicle is taking part in a training exercise in a mocked-up Afghan village. *(US Department of Defense)*

RIGHT The Kevlar-reinforced doors fitted to vehicles described as having 'basic armour', in this case a winch-equipped M1026, can be identified by the cruciform moulded into the centre panel to provide rigidity. There are also vertically sliding polycarbonate glazing panels. *(US Department of Defense)*

BELOW Interior view of the Kevlar door showing the sliding glazing panel in the open position. *(Simon Thomson)*



ABOVE LEFT Experience gained in the field in Afghanistan led to the use of welded rings on the armoured doors; these allowed blast-damaged doors to be ripped open using another vehicle, to rescue personnel who might be trapped inside. *(US Department of Defense)*

ABOVE Cargo/troop carrier configured with four Kevlar doors and the low rear cover. Note the shovel (and other items of the pioneer kit) stowed under the chassis at the rear. *(Simon Thomson)*

LEFT Two-door winch-equipped M1097 heavy Humvee variant cargo/troop carrier with the high cargo-bay cover. The vehicle, which is towing a Silver Eagle light tactical trailer (LTT), belongs to the tactical imagery production system of 1st Marine Division's combat camera and printing section. *(US Department of Defense)*

LEFT Privately-owned M997 cargo/troop carrier with a high cargo-bay cover and a stowage rack above the cab area. *(Simon Thomson)*

vinyl-coated cloth top, but there is also a range of easily removable glass-fibre composite Helmet hardtops produced by Amtech Military Products. There is also a two-door crew-cab top, a short-bed cargo cover and a so-called 'mid' hardtop. Soft covers for the cargo bay were produced in several patterns, including a low top that is attached to the top of the cab, and a high-level cargo cover.

LEFT Standard Helmet glass-fibre composite hardtop as produced by Amtech Military Products; other patterns include a two-door crew-cab hardtop and two heights of cargo-bay cover. Custom covers are also available. *(Simon Thomson)*

FAR LEFT M998 equipped with the standard Amtech Helmet hardtop, on which is mounted an STD-810 Stiletto screw-drive telescoping antenna mast. *(US Department of Defense)*

LEFT Short high-roofed custom-made hardtop mounted over the cargo bay in place of the standard rear hatch cover. *(Simon Thomson)*

LEFT Clips are provided inside the vehicle for the crew's M16 rifles or M203 grenade launcher. *(Jim Alexander)*

Optional fittings

Adjustable clips are provided inside the vehicle to allow the safe stowage of the crew's M16 rifles or M203 grenade launcher. Various types of brackets, footman loops, straps etc, are also provided to serve as stowage points for items such as ammunition boxes, fuel and water cans, missile launch tubes and ration boxes, etc. The number and type of these attachments depends on the variant and its intended role.

ABOVE Humvees do not routinely carry a spare wheel, but Ibis Tek manufactures a TACOM-approved rear-mounted swing-away spare-wheel carrier that incorporates a hand winch for handling the heavy wheel and tyre. *(Ibis Tek)*

RIGHT The standard factory brush guard is designed to prevent damage to the glass-fibre engine cover. The guard must be dropped down to allow the engine cover to be opened. *(Phil Royal)*

BELOW Ibis Tek also manufactures this combined heavy-duty tubular-steel 'pusher' bumper and brush guard. *(Simon Thomson)*

An extension is available to increase the height of the cargo barrier that is installed behind the front seats on two-door variants.

In order to prevent damage to the glass-fibre engine cover, a hinged steel brush guard is frequently bolted to the front cross-member; since 2007 some vehicles have featured a combined heavy-duty 'pusher' bumper and brush guard manufactured by Ibis Tek. The same company also produces a TACOM-approved rear-mounted swing-away spare-wheel carrier that incorporates a winch for handling the heavy wheel and tyre. The equipment is suitable for fitting to the M1025A2, M1097 (all variants), M1113, M1114, M1151 and M1152, unless the recipient vehicle is carrying a shelter.

Humvees have also been equipped with a rear-mounted rack designed to carry a Kawasaki KL-250D8 or similar trail bike. In this particular case the size of the Humvee is something of an advantage, since the motorcycle scarcely protrudes beyond the width of the vehicle.

And, finally, rather in the style of World War Two Jeeps, Humvees operating in Iraq and elsewhere frequently sport a wire-cutting bar fitted to the front bumper. Designed to avoid decapitation of the exposed gunner from wires stretched across the road, the bar is generally made from angle iron, extending above the height of the windshield, with a forward extension at the top designed to catch and cut any wires that would otherwise have posed a danger.

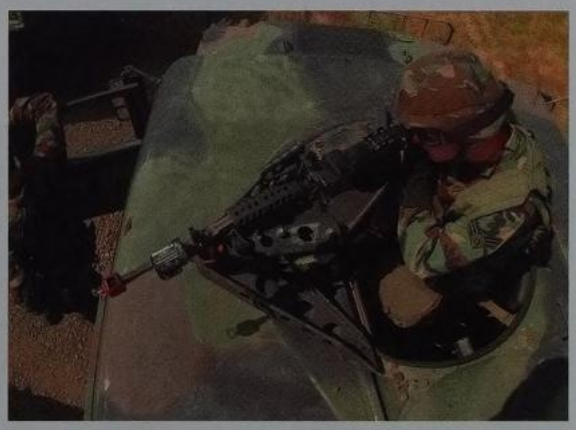
Weapons stations

The standard weapons mount is suitable for use with a 0.50in M2HB, 7.62mm M60 or 40mm machine gun, Mk19-3 40mm automatic grenade launcher, 30mm ASP-30 cannon or TOW missile system. Various configurations of armour have been produced to protect the normally exposed gunner whilst any roof-mounted weapon is in use, including three-sided turrets, forward-facing gun-shield panels and protective rear and side panels.

The so-called 'lightweight weapons station kit' is an adaptation of the mount provided with Humvee armament carrier variants. AM General claim around 80 per cent parts commonality with the standard weapons mount, and the kit is easily installed in the field without requiring special tools.

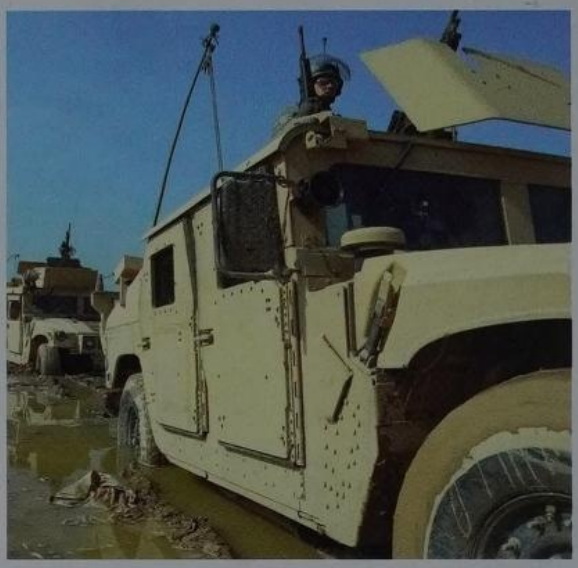
ABOVE **Overhead view showing the roof hatch and weapons mount.** *(Jim Alexander)*

BELOW **A pintle mount on the weapons ring can accommodate a variety of weapons: the vehicle nearest the camera has the M2HB 0.50in heavy machine gun, whilst the vehicle on the left mounts the Mk19 40mm grenade launcher.** *(US Department of Defense)*



LEFT **Roof hatch in use, with the two-part hinged cover open.** *(US Department of Defense)*

BELOW LEFT **Private First Class Matthew J. Mongiove, from the 10th Mountain Division, provides security for the Canadian Mobile Training Team near the Pakistan border at Spin Boldak, Afghanistan. The gun is the M240 7.62mm general-purpose machine gun manufactured by the Belgian armaments company FN.** *(US Department of Defense)*



ABOVE Soldiers of the 9th Psychological Operations Battalion, 4th Psychological Operations Group, man a checkpoint on the outskirts of Tall Afar, Iraq. Additional protection is provided by the gunner shield kit. *(US Department of Defense)*

ABOVE RIGHT As well as being provided with overhead protection against artillery fragments, the up-armoured M1114 also included under-body protection for the crew compartment. *(US Department of Defense)*

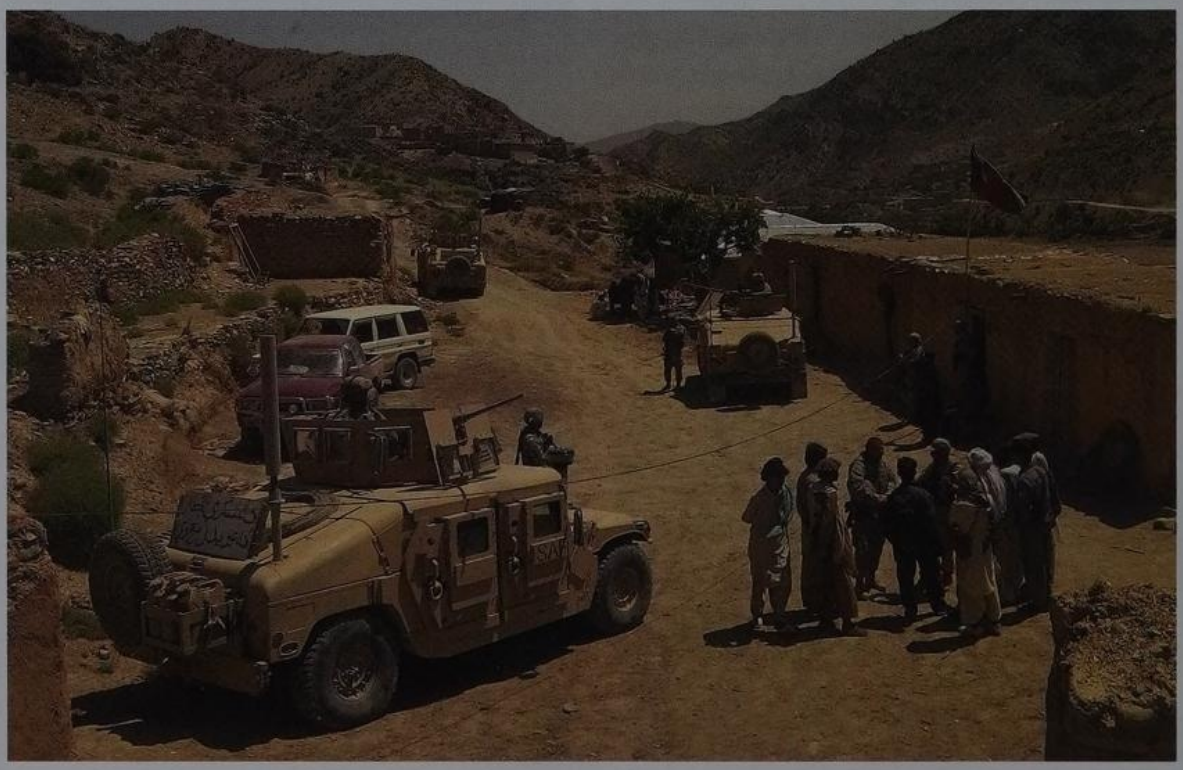
RIGHT The 'objective gunner protection kit' provides an armoured enclosure for the normally exposed gunner operating a weapon through the roof hatch. *(US Department of Defense)*

The M998 can be adapted to serve as a carrier for the M40A2 106mm recoilless rifle, using a modified version of the M825 mount that was originally developed for the M151. In this configuration the weapon provides a 180° field of fire, with a maximum elevation of 12° and a depression of between zero and -12° according to the azimuth. Examples of this variant were deployed by UNITA forces in Angola in 1989.

Armoured protection

In 1994 O'Gara-Hess & Eisenhardt started development work on the M1109 up-armoured Humvee (UAH), based on the chassis of the 'A1' series. With the addition of composite armour doors and *appliqué* panels attached around the crew compartment, the M1109 provided protection from 7.62mm armour-piercing (AP) rounds and overhead shrapnel from a 155mm artillery air-burst, whilst additional under-body panels provided blast protection from 12lb (5.45kg) anti-tank mines to both the crew and rear compartments. A modular add-on armour (AOA) kit was also developed that could be fitted to existing vehicles, which included side panels and mine-protected floor plates.

From about 2003, Humvees that had been fitted with improvised armour were described as being 'Level 3' protected, whilst Humvees



that had been fitted with the 'official' AOA kits were described as being protected to 'Level 2'. The 'Level 1' description was reserved for those vehicles that had been manufactured, or retrofitted during a rebuild, with integral up-armour kits.

Further armoured versions appeared in the guise of the M1114, M1115, M1116 and M1145, based on the expanded capacity variant (ECV), although the M1115 was not put into production. The armour, which consists of composite steel, aluminium and titanium panels, was designed to protect the crew against 7.62mm armour-piercing (AP) ammunition from a distance of 100m, and against anti-tank mines under either the front or rear axle, up to 12lb (5.45kg) and 4lb (1.18kg) respectively, and added something like 600lb (270kg) to the weight of the base vehicle.

In 2005 the M1151 and M1152 variants were introduced. These were modified to allow armour to be quickly and easily installed by crews in the field with as few tools as possible. Some basic armour, described as the 'integrated armour package' (IAP) 'A kit', is installed on the vehicle during the production process in hard-to-access areas such as the floors and behind the firewall; there are also installation points that allow the additional 'B kit' armour to be added as required. Production of the M1151 started in June 2005, with the M1152 following a month later. Work on the 'B kit' was scheduled for completion during October 2005.

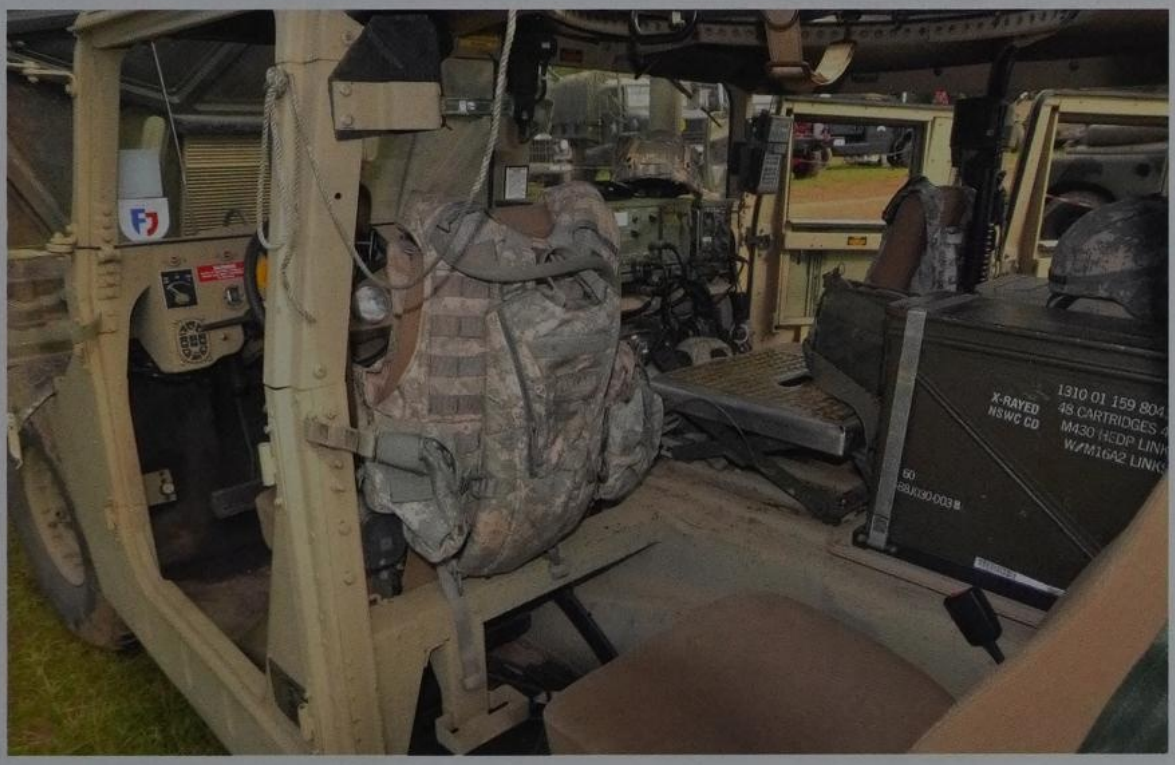
In addition, seven different 'fragmentation kits' have been developed allowing vehicles in service to be upgraded in various areas, including doors, fuel tanks, under-body areas and roof, etc.

Interior

It would be fair to say that the interior is spartan in that typical military manner – one commentator described it as 'all bare bones, shin-barking aluminium and steel' – with the individual front and rear seats separated by the huge transmission tunnel. The driver's seat is adjustable for height and reach, whilst the passenger seat can be removed to provide access to the battery box. The front seats were improved with the introduction of additional padding and higher backs on the 'A1' upgrade, and the rear seats were similarly improved when the 'A2' was introduced, but the comfort of the crew appears, nevertheless, to be a secondary consideration.

The rear seats of the cargo/troop carrier variant are designed to fold to increase cargo capacity.

The flat surface of the transmission tunnel between the front seats provides a useful



LEFT General interior view illustrating how relatively cramped the interior can become when filled with kit. *(Phil Royal)*

ABOVE The size of the transmission tunnel results in a somewhat cramped driving position. *(David Doyle)*

ABOVE The original seats were low-backed and offered little in the way of comfort or support. *(David Doyle)*

equipment shelf, for example for a radio set or other electronic equipment.

Paintwork and markings

Some very early Humvees may well have been painted in the camouflage scheme that had been devised by the US Army's Mobility Equipment Research & Design Command (MERDC). Introduced in 1974, the scheme saw vehicles finished in a standard disruptive pattern that drew four colours from a palette of 12 using Federal Standard FS-595A or B. The colours, which are applied in such a way that they break up the shape of the vehicle to make identification difficult, were selected to suit the weather and terrain in which the vehicle was operated.

In about 1985, soon after the Humvee went into production, the US Army abandoned the MERDC scheme in favour of a slightly more simplified system. The new system used a three-colour camouflage pattern, for example, a Forest Green (FS-595 34127) base coat with disruptive patches of Brown (FS-595 30117) and Flat Black (FS-595 37038); in this case the chassis, driveline and suspension components would also be painted in Flat Black. Other

RIGHT Typical northern hemisphere three-colour camouflage pattern using black and tan over a base coat of green. Note how the shade of the tan on the front door does not match that on the sill. *(US Department of Defense)*

ABOVE Humvee of the United Arab Emirates painted in the distinctive three-colour northern hemisphere camouflage pattern. The vehicle is assigned to the KFOR mission in Kosovo in 1999. *(Carl Schulze)*

colour schemes include a base coat of Desert Sand (FS-595 30279), Sand (FS-595 30277 or 33303) or Flat White (FS-595 17875), with appropriate disruptive markings.

The camouflage pattern is laid down in US Army Technical Manual TM 43-1039 *Painting Instructions for Army Materiel*, and the colours are selected from a palette of around 20, according to the theatre for which the vehicle is intended. Based on polyurethane and epoxy polyamide resins, the paint is described as a chemical agent-resistant coating (CARC), and this acronym is also often used to identify the camouflage scheme. The paint is formulated to both resist contamination by chemical agents used as a weapon, and to make the finish easy to decontaminate should exposure take place.

Any markings on the vehicle – for example air-recognition symbols, unit markings, tyre pressures and legends such as 'sling', 'tie-down' or 'no step' – are applied in matt black or white paint using standard military-style stencils, or as self-adhesive vinyl lettering. Many vehicles will be seen with distinctive red and yellow decals on the rear to ensure high

ABOVE From around 2004, in response to regular attacks on Coalition forces, the US Department of Defense started fitting armour to existing vehicles that were already deployed in Iraq. Interestingly, these green-painted Humvees have been fitted with sand-coloured doors and under-body protection components. *(US Department of Defense)*

LEFT Years of US involvement in the Middle East means that, like this up-armoured M1114, a large proportion of the US Army's Humvee fleet has been painted sand. The photograph shows soldiers from 1st Battalion, 13th Armor Regiment, 3rd Brigade, 1st Armored Division, preparing to search buildings in Taji, Iraq. *(US Department of Defense)*

TABLE 3: ENGINE AND PERFORMANCE DATA			
	M998 and M998A1 series	M998A2 series	ECV series
Engine			
Type	GM Detroit Diesel Allison	GEP 6500	GEP 6500 Optimizer
Cylinders	V8	V8	V8
Swept volume	6,217cc (379.4cu in)	6,468cc (400i cu in)	6,468cc (400cu in)
Bore	3.98in (101mm)	4.06in (103mm)	4.06in (103mm)
Stroke	3.82in (97mm)	3.82in (97mm)	3.82in (97mm)
Inlet system	Normally aspirated	Normally aspirated	Turbocharged
Compression ratio	21.3:1	21.3:1	20.2:1
Performance			
Maximum power output	150bhp at 2,000rpm	160bhp at 3,400rpm	190bhp at 3,400rpm
Maximum torque	260lbf/ft at 2,000rpm	285lbf/ft at 1,700rpm	380lbf/ft at 1,700rpm
Idle speed	650rpm, ±25rpm	725rpm, ±25rpm	650rpm, ±25rpm
Maximum engine speed (full load)	3,600rpm	3,400rpm	3,200rpm
Maximum engine speed (no load)	4,000rpm	3,650rpm	3,400rpm
Transmission			
Gearbox	GM 3L80; automatic; 3F1R	GM 4L80; automatic; 4F1R	GM 4L80; automatic; 4F1R
Transfer box	NPG 218; two-speed	NPG 242; two-speed	NPG 242; two-speed
Driveline	Full-time 4x4	Full-time 4x4	Full-time 4x4
Servicing data			
Firing sequence	1-8-7-2-6-5-4-3	1-8-7-2-6-5-4-3	1-8-7-2-6-5-4-3
Direction of rotation	Clockwise	Clockwise	Clockwise

visibility during operations on normal roads. On ambulance variants, red cross symbols – on removable placards – are placed at six locations; one each on the rear doors, sides, front and top of the body.

Other colour schemes are used by other nations: the Saudi National Guard, for example, paints their vehicles in overall Desert Sand without any camouflage pattern, and some Kuwaiti vehicles are finished in a complex blue, black and grey disruptive pattern. Iraqi Army vehicles have their own distinctive camouflage pattern, whilst Iraqi police vehicles are often painted mid-blue.

Tools and accessories

The following items form part of the basic on-board equipment; the pioneer tools (axe, shovel and mattock) are carried in a drop-down rack normally stowed under the rear of the cargo bay:

- Airlift spreader-bar assembly
- Axe
- Equipment log book
- Fire extinguisher
- First aid kit
- Jack and handle
- Mattock and handle
- NBC (nuclear, biological, chemical) adapter for the filter unit inlet
- NBC hose assembly
- Shovel
- Spare bulb kit
- Technical manuals TM 9-2320-280-10 and TM 9-2320-280-10-HR in a cotton duck pamphlet bag
- Tool bag
- Tools, including pliers, flat- and cross-head screwdrivers and adjustable spanner
- Wheel nut (lug) wrench

The official technical documentation also includes a long list of additional authorised equipment that can be carried under particular circumstances, including, for example, a NATO inter-vehicle slave cable, chemical decontamination equipment, radio equipment, tyre chains, towing chain, reflective warning triangle and spare wheel assembly, etc.

TABLE 4: MAJOR MODIFICATIONS INTRODUCED DURING PRODUCTION

Description of modification
M998A1 series
Improved brake pads
Improved front seats with added padding
Improved master cylinder
Improved parking-brake lever
Improved seals to steering and suspension ball joints
Metal cooling grille insert in engine cover
Modified rifle mounts
New transfer case with 2.72:1 ratio and improved lubrication
Redesigned electrical slave receptacle
Redesigned front axle assembly with 2.73:1 differential
Solid-state controller for glow plugs
Strengthened propeller shafts
Variable-rate rear springs
M998A2 series
Dual-voltage 14V/28V electrical system
Improved heating facilities
Improved rear seats (where applicable)
Improved steering and suspension ball joints
Improved suspension upper control arms
Improved weather protection and rust-proofing
Larger-diameter brake discs
LED side markers
New air cleaner
New design of run-flat insert
New four-speed electronically controlled transmission
New steering wheel and column
New, more powerful diesel engine
Redesigned exhaust system with catalytic converter
Self-cancelling facility on turn indicators
Strengthened front cross-member
Strengthened tie-down mounts
Use of radial tyres in place of bias-belt design
M1100 series
Addition of cooler to rear differential
Geared fan drive
New 24-bolt wheels
New A-arm bushes
New design of parking brake
New power steering pump
New shock absorbers
New three-piece chassis main rails and cross-members
New, more powerful turbocharged diesel engine
Redesigned air-lifting brackets
Redesigned reduction hubs
Redesigned steering system to reduce effort

OPPOSITE The width of the transmission tunnel provides plenty of space to mount radio and other communications equipment. This is the transceiver RT-524A/VRC, with inbuilt loudspeaker forming part of a typical AN/VRC-12 series radio station. *(Phil Royal)*

RIGHT The radio antenna (AS 1729/VRC or AB-652/GR) and associated mounts are normally attached to the rear corners of the vehicle. *(David Doyle)*

Optional equipment

AM General sales material for the Humvee lists the following optional equipment 'to enhance the Humvee's capability and/or enable it to perform specific missions':

- Air conditioning
- Arctic kit
- Brush and headlight guard
- Bulkhead spare-tyre carrier
- Central tyre-inflation system (CTIS)
- Communications mounting
- Constant fan drive
- Counter-mine armour kit
- Crew and cargo area canvas
- Deep-water fording kit
- Desert filtration package, including secondary oil and fuel filtration, sealed

BELOW This US Marines M998 has been fitted with expedient armoured sides and half-height armoured doors. Most noteworthy, however, is the field-fabricated stowage arrangement at the rear, designed to hold five standard fuel or water containers. *(US Department of Defense)*

dipstick, 'solid' fan drive and enhanced air filtration
- Driveline protection kit, consisting of front and rear differential cross-member guards, frame cross-member guards, fuel tank protection plate and transfer case shield
- Dual antenna mounts
- Extended air-intake stack for deep-water wading
- Hardtop and doors
- Heater for troop-carrying compartment
- Jerrycan holder
- Lightweight weapons station kit
- Metric-marked instruments
- Pedestal weapons mount
- Radial run-flat tyres, or radial tyres with bead-lock inserts
- Selective up-armour
- Snow chains
- Special paint
- Swing-out spare-tyre carrier
- Troop seats for eight men
- Twin oil filters
- Under-body skid protection
- Vertical exhaust pipe extension for use during wading
- Winch

Some of these items are described separately, but note that not all of the items are suitable for every variant.

BELOW Privately owned M1025 armament carrier equipped with a gunner shield kit, Ibis Tek heavy-duty pusher brush guard and front bumper, and rear-mounted spare-wheel carrier. The rear hatch can be configured to hinge from the top or the bottom. *(Simon Thomson)*

'The Humvee significantly enhances the mobility of US Armed Forces and foreign armies in various combat, combat support and combat service support roles.'

AM General. Introduction to the Humvee M998 series

Chapter Five

The Humvee in action

Designed for use across all types of terrain, including deep mud and sand, and in all weather conditions, the Humvee is suitable for a wide range of roles, including troop transport, weapons carrier, armed reconnaissance, combat support and field ambulance; it also provides a mount for communications shelter. Whilst never intended for front-line combat, it is, nevertheless, an enormously capable machine that has more than proved itself in service in the Balkans, the Middle East and South-East Asia.

OPPOSITE Winch-equipped M1026 armament carrier during a convoy operations class in March 2007, at a range on Fort Dix, New Jersey. The crew are US Air Force airmen of the Air Force Advanced Contingency Skills Training Course.
(US Department of Defense)

ABOVE US Marines M1044 armament carrier with supplemental armour leading a convoy of white-painted UN vehicles on the road from Mogadishu to Biadoa in Somalia. The vehicle retains its stencilled plywood shipping tag. *(US Department of Defense)*

The US 9th Infantry (Motorized) Division, based at Fort Lewis in Washington and generally known as the 'Old Reliables', was the first unit to be issued with the new Humvee when, in 1985, it was chosen as a test-bed to develop a so-called 'motorized division' intended to counter the similar units operated by the Soviet Union. The first examples were delivered to Fort Lewis in March 1985, and between 1985 and late 1991 the vehicle was put through its paces, both at Fort Lewis and at the Yakima Training Center, Washington. Two brigades were formed, each with three battalions, one battalion designated 'light

RIGHT Men of the US Army 2nd Battalion, 8th Field Artillery, inspecting a weapons site in May 1989. *(Staff Sergeant Lem Robson; US Department of Defense)*

RIGHT Standing beside an M1114 up-armoured armament carrier, soldiers from 1st Battalion, 198th Armor Regiment, 155th Brigade Combat Team, assist Iraqi police at a checkpoint in Najaf, April 2005. Note the field-expedient cylindrical armoured shield for the roof gunner. *(US Department of Defense)*

attack', one as 'light combined arms' and the third as 'heavy combined arms'. In 1991, following the end of the Cold War, the 'motorized division' concept was dropped, but it was felt that the exercise had improved both battlefield mobility and movement tactics.

The Humvee saw its first combat action in December 1989 as part of 'Operation Just Cause', the US invasion of Panama, where, in the words of the US Army, it proved itself to be 'reliable, durable and battleworthy'. In 1990 Humvees helped to support the Western-backed UNITA rebels in Angola. More action came a year later when US Army Humvees were deployed to 'Operation Desert Shield' and the subsequent 'Operation Desert Storm' in Kuwait. The press mourned the fact that this was 'the first time in 50 years that the Jeep doesn't go to war', but the Humvee demonstrated that it was equally at home in the deserts of the Middle East as it was in the urban environment that had typified the Panama operation. Elements of the 1st Cavalry Division even preferred the Humvee to the armoured Bradley infantry fighting vehicle (IFV) for scouting

LEFT Based on the chassis of the M1097A2, the up-armoured M1114 started to enter service in 1996. Here, soldiers from the US Army A Battery 3rd Battalion, 320th Field Artillery Regiment, 101st Airborne Division, are preparing to convoy in Forward Operation Base Remagen, Iraq, April 2006. *(US Department of Defense)*

RIGHT Using the wide, flat expanse of the Humvee engine cover as a table, US Army Captain Aaron Parker, Commander, Delta Company, Task Force 2nd Squadron, 11th Armor Cavalry Regiment, counts out 8.3 million Iraqi dinars (about $7,500) found on a suspected insurgent during a mounted patrol. *(US Department of Defense)*

ABOVE RIGHT Equally, the engine cover provides an excellent map table – here, US Air Force Technical Sergeant Jennifer Buckner checks the convoy route with fellow airmen during 'Operation Northern Thunder' at Camp Rilea in Warrenton, Oregon, June 2007. *(US Department of Defense)*

missions, citing its speed and size as distinct advantages.

President George W. Bush is said to have eaten his Thanksgiving Day turkey dinner from the engine cover of a Humvee, a practice that can be traced back to World War Two when Allied troops often used the flat engine cover of the Jeep for the same purpose. And Bob Hope used a Humvee, which he described as an 'armoured golf cart', as transport in Saudi Arabia as he travelled around entertaining troops.

In December 1992 Humvees participated in 'Operation Restore Hope' with United Nations troops in Somalia. However, the ill-fated US Army attempt to rescue downed helicopter crews during the Battle of Mogadishu with Somali militia in October 1993 made it very apparent that there was a need for a lightly armoured variant, and within a year work had started at O'Gara-Hess & Eisenhardt to develop the M1109 armoured Humvee.

The Humvee has also, more recently, been used in Croatia in 1995, and in Bosnia-Herzegovina as part of the international implementation forces during 'Operation Joint Guard' and 'Operation Joint Endeavour' in 1996–98. More than 10,000 examples were deployed by US forces during 'Operation Iraqi Freedom' in 2003, and most recently in 'Operation Enduring Freedom' in Afghanistan. During these operations, the asymmetric nature of the conflict has highlighted the

RIGHT Private First Class Raymond Purtee, from the 561st Military Police Company, attached to the 10th Mountain Division, provides convoy security during a patrol near Bagram, Afghanistan, November 2006. The vehicle is a winch-equipped M1151A1 armament carrier. *(US Department of Defense)*

shortcomings of the standard Humvee variants which, of course, remain unarmoured. Like the British Army's Land Rover, the Humvee was not designed to withstand powerful roadside bombs, and whilst some limited success has been achieved with *appliqué* armour the subsequent attempts at providing protection for the crew have tended to highlight other weaknesses in the vehicle.

As the *Phoenix Gazette* put it, 'Hummer no bummer when it comes to battlefield'!

The military role of the Humvee

Little is left to chance in the military, and US Army technical publication TM 9-2320-2810-10 includes a description of the intended role of each of the basic variants. However, it should be remembered that the Humvee is a very versatile machine and a comprehensive list of military roles would extend to several pages; see Table 5, page 108.

TM 9-2320-2810-10 states that the cargo/troop carrier (M998, M1038, M1097 etc) is used 'to transport equipment, materials, and/or personnel', the payload varying according to the specific variant. In troop-carrying mode, the addition of the troop seat kit allows eight passengers to be carried as well as a two-man crew; the vehicle can also be configured for a four-man crew. The M1097 heavy Humvee variant (HHV) is fitted with a 200Ah umbilical cable to power shelter equipment, and has stowage racks for ammunition and equipment. As the name suggests, the TOW missile carrier (M966, M1036 etc) is used to mount and operate the BGM-71 TOW (tube-launched, optically tracked, wire command-link) anti-tank guided-missile launcher system, and provides light armoured protection for the crew, the missile system and the ammunition. M1045, M1046 and other variants are fitted with supplemental armour.

Armament carriers (M1025, M1026 etc) are fitted with a ring mount, providing a full-circle arc of fire for the Mk19 automatic grenade launcher, and a 7.62mm general-purpose or 0.50in heavy machine gun. Light protection is provided for the crew, the weapon components and the ammunition. M1043, M1044 and other variants are fitted with supplemental armour.

The purpose-designed shelter carrier (M1037, M1042) provides the capability to secure and transport the S250 (or similar) electrical equipment shelter without any overhang, with a total payload, including a two-man crew, of 3,600lb (1,634kg). Other suitable shelter types include the 'mobile subscriber equipment shelter' (MSE) and the 'standard integrated command post systems' (SICPS) shelter.

The three field ambulance variants (M996, M997 and M1035) are designed to carry a combination of stretcher and ambulatory patients, the exact number and arrangement depending on the specific variant. Both the M996 and M997 variants are provided with what is described as 'collective NBC' (nuclear, biological, chemical) filtration and a gas particulate filter unit (GPFU) and heating system that feeds temperature-controlled filtered air to protective masks for the patient.

Weapons

AM General list the following weapons as being suitable for mounting on the Humvee:

- BGM-71 TOW and TOW-II anti-tank missile systems

BELOW The TOW missile carrier is designed to mount a Raytheon tube-launched, optically tracked, wire-guided (TOW) anti-tank missile system designed for use against tanks and other armoured vehicles. Here, Private First Class Colin Hoffmeyer of the US Army 101st Airborne Division demonstrates the weapon at Fort Knox, Kentucky, in December 2011. *(Sergeant Jon Heinrich; US Department of Defense)*

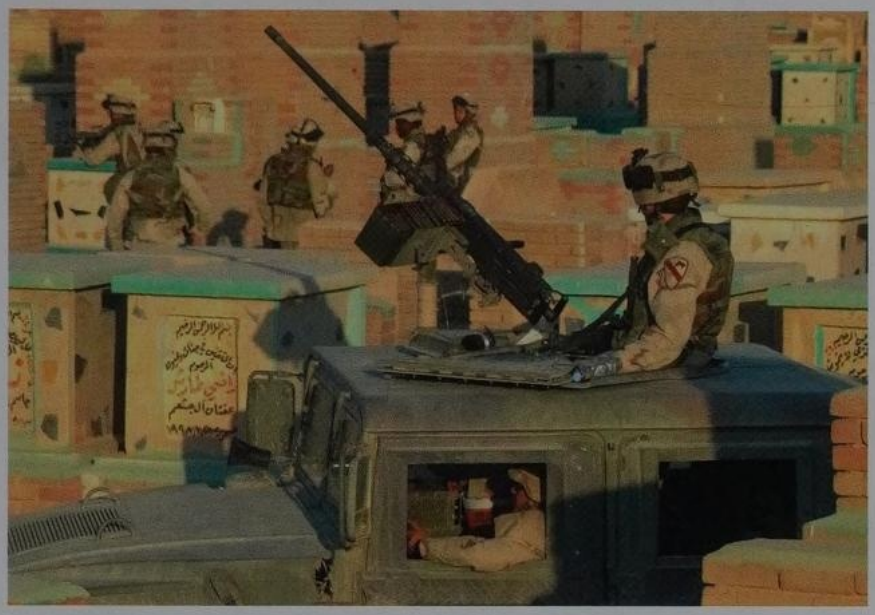
LEFT **Although now superseded by the more sophisticated TOW missile, the M40A1 106mm recoilless rifle nevertheless remains effective against lightly armoured targets. The weapon is commonly found mounted on a Jeep or Land Rover, but the M998 cargo/troop carrier Humvee is equally suitable.** *(AM General)*

BELOW **A military policeman of the 4th Infantry Division's 4th Military Police Company provides security from the turret of an up-armoured Humvee in October 2003. The weapon is a Mk19-3 40mm automatic grenade launcher.** *(US Department of Defense)*

RIGHT **Leaning on his M2HB 0.50in heavy machine gun, a soldier of US Army Company C, 1st Battalion, 124th Infantry Regiment, guards the mayor's office in Ar Ramadia, Iraq, January 2004. The vehicle is an open-sided M1025A2 armament carrier with field-expedient half doors.** *(Staff Sergeant Joseph Roberts; US Department of Defense)*

RIGHT **Close-up view of the M2HB 0.50in heavy machine gun in the pintle mount; the vehicle is also fitted with multi-barrelled smoke grenade launchers on the front corners of the roof.** *(Phil Royal)*

RIGHT Soldiers of the US Army 1st Cavalry Division search the cemetery in An Najaf, Iraq, for weapons caches and insurgent fighters, August 2004. The vehicle, which mounts an M2HB 0.50in heavy machine gun, is an M1043 armament carrier with supplemental armour; an additional layer of Kevlar *appliqué* armour has also been attached to the doors. *(US Department of Defense)*



- GAU-19 0.50in three-barrel Gatling gun
- Giat M621 20mm cannon
- Giat M781 30mm cannon
- M2HB or M2HB-QC8 0.50in heavy machine gun
- M40A2 106mm recoilless rifle
- M60 or M240 7.62mm general-purpose machine gun (GPMG)
- M249 5.56mm general-purpose machine gun (GPMG)
- McDonnell Douglas ASP-30 30mm cannon
- MILAN anti-tank missile system
- Mistral anti-aircraft missile system
- Mk19 40mm automatic grenade launcher
- Starburst anti-aircraft missile system
- Stinger anti-aircraft missile system

LEFT Mk19 40mm automatic belt-fed grenade launcher. Manufactured by Saco Defense Industries, this weapon first saw service in 1968, and has served through the Vietnam War, the various conflicts in the Middle East and into Afghanistan. *(Master Sergeant Paul D. Charron; US Department of Defense)*

LEFT Close-up view of the TOW missile launcher mounted on the roof of an M1045. The photograph was taken at Stinger Range, Yuma, Arizona. *(Sergeant Benjamin R. Reynolds; US Department of Defense)*

ABOVE M998 cargo/troop carrier slung beneath a Boeing CH-47 Chinook helicopter. Photographed in South Afghanistan in 2010. *(Senior Airman Kenny Holsten; US Department of Defense)*

Air-portability

All Humvees are air-portable, with three vehicles able to be carried in a C-130 Hercules transport aircraft, four in a C-130J-30, six in a C-141B, ten in a C-17, and fifteen in a C-5A Galaxy.

Two Humvees can also be slung beneath a CH-47 or CH-53 helicopter, and a single vehicle beneath a UH-60, although in the latter case any shelter would have to be removed. With the exception of the M997, M1037 and M1042 (with the shelter installed), the vehicle was suitable for conventional air-drop, or packed on special pallets for air delivery using the low-velocity air-drop or low-altitude parachute-extraction systems.

Radio equipment

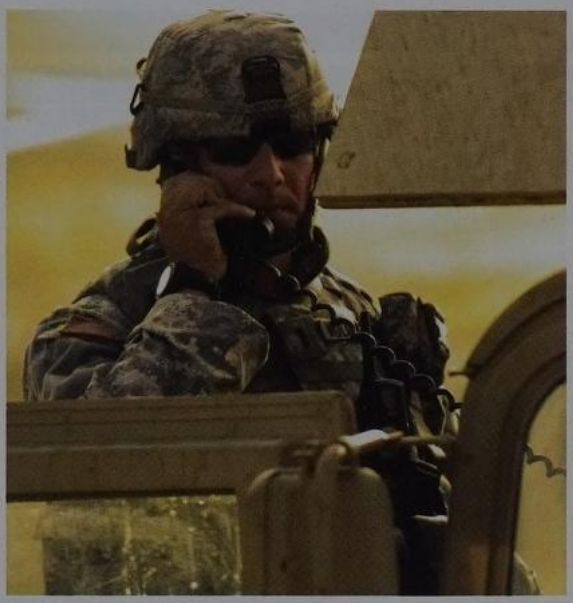
The forward end of the transmission tunnel provides an ideal shelf on which to mount radio equipment. The actual choice of specific equipment depends on the age and role of the vehicle.

The following stations will be commonly encountered in early Humvees:

- AN/VRC-12
- AN/VRC-43
- AN/VRC-44
- AN/VRC-45
- AN/VRC-46
- AN/VRC-47
- AN/VRC-48

These stations are generally referred to collectively as the AN/VRC-12 series and operate on the 30.00 to 75.95MHz spectrum, in two ranges. Each consists of the following equipment arranged in different combinations: transceiver RT-246A/VRC, with ten pre-set channels but without loudspeaker; transceiver RT-524A/VRC, with loudspeaker; and auxiliary receiver R-442A/VRC. Auxiliary equipment includes the mounting MT-1029, which is used for the RT-246 and RT-524 transceivers, and mounting MT-1898, which is used for the R-442. Mounting MT-1029 also holds the power supply and audio amplifier AM-2060

RIGHT M1025 armament carrier being guided down the loading ramp of a Lockheed C-5B Galaxy cargo aircraft at Mogadishu Airport in 1993. *(Sergeant M. Preston; US Department of Defense)*



for the associated PRC-25 and PRC-77 man-pack radios. Other accessories include the microphones and headsets, power supply units, radio control boxes, transient and mini transient suppressor and cable harnesses, etc. The antenna (AS 1729/VRC or AB-652/GR) and associated mounts are normally attached to the rear corners of the vehicle.

From about 1988 the US Army started to replace the older radios such as the AN/VRC-12, which dated from the Vietnam War era, with a new single-channel ground and airborne radio system (SINCGARS). The new equipment offers single-frequency and frequency-hopping (ECCM) capabilities both for voice and data transmission, and is manufactured by ITT, Magnavox, General Dynamics and a consortium of ITT and Thales. The system operates on any of the 2,320 channels between 30 and 88MHz, and is designed to survive in a nuclear environment, providing a reliable, secure, easily maintained combat net radio (CNR) with both voice and data handling capability. SINCGARS stations commonly installed in the Humvee include:

- AN/VRC-88
- AN/VRC-89
- AN/VRC-90

Station AN/VRC-88 is a vehicle-mounted radio that can be dismounted and reconfigured as an AN/PRC-119 man-pack; it replaces the AN/GRC-160. AN/VRC-89 consists of one short-range and one long-range securable transceiver for operation on two nets simultaneously, and

ABOVE LEFT US Army 1st Lieutenant Keith Wolowodiuk of the 1st Battalion, 185th Infantry Regiment, 40th Infantry Division, California National Guard, gives convoy instructions prior to leaving for field training at Fort Dix, New Jersey, in July 2007. *(US Department of Defense)*

ABOVE From about 1988 the US Army started replacing the AN/VRC-12 series with a new single-channel ground and airborne radio system (SINCGARS). The new equipment offers single-frequency and frequency-hopping capabilities both for voice and data transmission, and operates on any of the 2,320 channels between 30–88MHz. *(David Doyle)*

BELOW US Air Force Staff Sergeant Mitch Yang of 4th Air Support Operations Group communicates with an air-support aircraft during a convoy mission in northern Iraq. *(US Department of Defense)*

TABLE 5: HUMVEE SPECIAL APPLICATIONS

Designation	Description
AB19	M1097 with NORINCO multiple launch rocket system (MLRS); in service with Jordan
ADS	Riot-control vehicle, with 95Ghz non-lethal active denial system (ADS); *see also Sheriff*
Antelope	Trials version of Chung Shan Institute of Science and Technology (CSIST) Sky Sword 1 anti-aircraft missile system
Asset IV	Sierra Research aircraft survivability equipment trainer
ASRAD Hellas	Greek Army Stinger short-range air-defence system
Assault	Modified for hostage rescue
Atlas	Atlas launcher for Mistral air-defence missiles
Avenger	M1037-based Stinger missile low-level air-defence system
Basque	Spanish police vehicle
BOR-A	BOR-A 550 ground-surveillance radar
Bushmaster	M242 Bushmaster 25mm chain-driven cannon
CBSS Scout	Coastal border surveillance system
CLAWS	*See HumRAAM*
Coyote	General Dynamics M56 smoke-generator system
CP30	Giat 30mm cannon mount
Crossbow	Ling-Temco-Vought (LTV) pedestal-mounted missile system
CROWS	Fitted with weapons mount for overhead 0.50in machine gun
DumVee	Special forces ground mobility vehicle (GMV); also described as desert mobility vehicle (DumVee). Based on M998 and M1026 and produced in four variants: GMV-M (Marine Corps); GMV-N (Navy Special Warfare Command); GMV-R (Rangers); and GMV-S (Special Operations Command)
EOD	Modified for use by explosive ordnance disposal teams
Firefinder	Command, control and communications (C3) vehicle for Hughes Firefinder AN/TPQ-36 weapons-locating radar system
GMV	*See DumVee*
GRC-408E	Fitted with communications box body for GRC-408E line-of-sight, multi-channel, radio-relay system
Guardian	Boeing/Matra Guardian air-defence system
Hellfire	Launcher for AGM-114 Hellfire air missile
HMGCS	Control vehicle for unmanned aerial vehicle (UAV)
HMMWV RCV	Humvee (M998) remote-controlled vehicle
HumRAAM	Launch system for MIM-120 advanced medium-range air-to-air missile (RAAM) system; also called SlamRAAM, Project 559 and CLAWS
Hydra	2.75in Hydra-70 rocket launcher mount
IMETS	Fitted with integrated meteorological system (AN/TMQ-40 or 41 IMETS)
Jaegerkorpset	Royal Danish Army special forces vehicle
Knight	Fitted with M707 target acquisition system; *see also Striker*
Kornet	Greek Army anti-tank guided missile (ATGM) launcher
Margot	Fitted with Greek Margot explosive ordnance disposal (EOD) body
MGM-157	Fitted with enhanced optical fibre guidance (EFOG-M) system for vertical-launch missiles
MGM-166	Lockheed-Martin MGM-166 LOSAT (line-of-sight, anti-tank) surface-to-surface missile launcher
MRTVS	Box body equipped as base television studio
Oversnow	Fitted with modified wheels for use in deep snow
Packhorse	Conversion to tractor for semi-trailer
Project 559	*See HumRAAM*
Prophet	Radio communications interception system
Raven	Launch vehicle for unmanned aerial vehicle (UAV)
Scorpion	Vasliyek 82mm automatic mortar
Setter	Ling-Temco-Vought (LTV) mobile air-defence system mounting multiple Stinger missiles
Sheriff	Vehicle-mounted active-denial system (VMADS) for riot control; *see also ADS*
SlamRAAM	*See HumRAAM*
Smoke generator	M1113 fitted with smoke generator
Special ops	M1025 or M1114 modified for special operations
Spike	M1045A2 of Polish Army modified to carry Rafael Spike-LR anti-tank missile launcher
SRMAS	M1123 with Singapore Technologies super rapid advanced 120mm mortar system
Starstreak Avenger	Shorts/Boeing Starstreak Avenger air-defence system
Stinger	M998-based Stinger missile supply carrier
Striker	M1025A2-mounted M707 target acquisition system; name changed to Knight to avoid confusion with Stryker light infantry vehicle
T3H	Tactical communications vehicle
Tumak-1, 2, 3, etc	Polish Army variants
VISMOD	M998 modified to resemble Soviet BRDM-2 scout car
Zeus	Humvee laser ordnance-neutralisation system (HLONS)

BELOW Front view of an M1038 with the half-finished shell of a mock Soviet BRDM-2 scout car being built around it. Described as VISMOD, the vehicle will be used by the 177th Armored Brigade in their role as an opposing force during exercises. *(US Department of Defense)*

replaces existing AN/VRC-46, AN/VRC-47 and AN/VRC-64 configurations. The AN/VRC-90 is a long-range set with a securable transceiver for use where the communications range must normally operate over distances of more than 20 miles (35km); it replaces the AN/VRC-46. Although the new equipment has now replaced the older system, there was a period during which the two were operated side-by-side.

CIP panel

Humvees in combat zones will normally be seen sporting a louvred 'combat identification panel' (CIP) either on the engine cover or on the sides of the vehicle. Developed during the Gulf War, the CIP is designed to produce a distinct and easily identifiable infrared signature when seen through the thermal-imaging system of an aircraft or armoured fighting vehicle, with the intention of reducing friendly-fire incidents.

Towing

The maximum gross weight of the trailer and its payload for the M998 series should not exceed 8,400lb (1,544kg), whilst the maximum towed load capability of the heavy variant is 4,200lb (1,907kg).

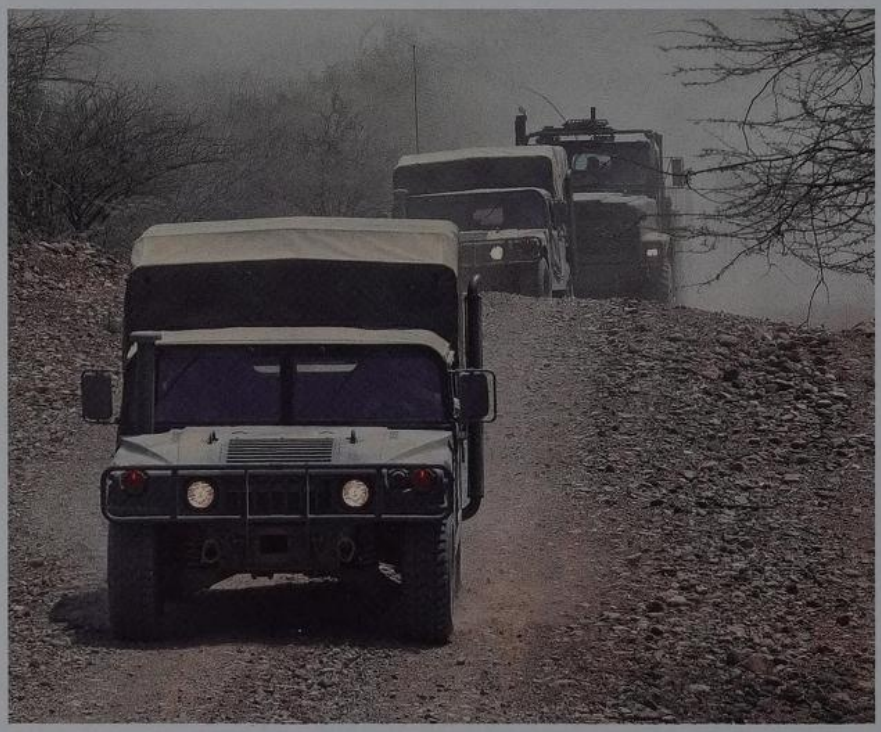
The light tactical trailer (LTT) has been standardised for use with the Humvee and is produced by the Silver Eagle Manufacturing Company of Portland, Oregon, in both flat-bed (LTT-F, M1101) and cargo (LTT-H, M1102) configurations. With a unitised body constructed from aircraft-grade aluminium alloy and chrome-molybdenum steel, the LTT is rated for a payload of 2,740–2,920lb (1,243–1,325kg). The trailer matches the width and wheel-track of the Humvee, and has a similar ground clearance. It also uses the same lights, shock absorbers, wheels and tyres.

Other authorised trailers include the 0.75-ton M116 and M101 series. The Humvee is also authorised as a tow vehicle for the M101 and M102 105mm howitzer and, of course, the M1069 was designed as the prime mover for the M119 105mm light gun.

ABOVE A convoy of US soldiers, led by an up-armoured M1109, head towards Kladanj, Bosnia-Herzegovina, to attend a meeting between Bosnia-Herzegovina factions and Serbian forces to discuss clarification of the Zone of Separation. *(US Department of Defense)*

LEFT US Marine Corps personnel assigned to the Battalion Landing Team, 1st Battalion, 6th Marines, 22nd Marine Expeditionary Unit, Special Operations Capable (SOC), conduct a brief security halt while travelling in a convoy. The vehicle nearest the camera is an M1043 with supplemental armour. *(US Department of Defense)*

LEFT A convoy of M1114 up-armoured armament carriers photographed in the Ninewa province of Iraq. The vehicles belong to the US Army 3rd Armored Cavalry Regiment, 2nd Squadron (Saber), Lion Battery, normally based at Fort Carson, Colorado. *(US Department of Defense)*



CENTRE A pair of M1097 heavy Humvee variants lead a US Marine Corps convoy on a dirt road towards Camp Lonestar, in Nginyang, Rift Valley Province, Kenya, in preparation to participate in 'Exercise Natural Fire 2006'. This exercise is the largest conducted by US and East African community nations. *(US Department of Defense)*

The soldier's view

To US military personnel, more used to the harsh ride and wayward handling of machines such as the M151 MUTT and the M561 'Gama Goat', the Humvee must have been something of a revelation.

Whilst the driving characteristics of the 'Gama Goat' were legendary, with its four-wheel steering making for somewhat eccentric handling on the road, the M151 was far worse, and the swing-axle suspension set-up was considered to make the vehicle so prone to unpredictable roll-over accidents that drivers required special training, and the government was not prepared to risk selling surplus M151s to the public.

By comparison, the Humvee is a fast, agile and stable vehicle, making it a far more effective weapons platform, whilst the automatic transmission reduces the need for driver training. And the off-road performance would have made M151 drivers weep – 'Humvees are the best vehicles ever made', wrote Chief Warrant Officer Michael Sunderhaus of 226th Maintenance Company: 'I love that thing... it goes anywhere...

LEFT Towing an elderly M101 or M116 series 0.75-ton two-wheeled trailer, a US Army M1165A1 participates in a battle rehearsal drill involving convoy security and improvised explosive device response. Both the Afghan Army and the Afghan police service were also involved. The location is Forward Operating Base Warrior, May 2007. *(US Department of Defense)*

RIGHT The Humvee is capable of wading, unprepared, to a depth of 30in (762mm); with the deep-water wading kit fitted, the figure increases to 60in (1,524mm). *(AM General)*

BELOW One of the world's most capable wheeled off-road vehicles, the Humvee is easy to drive on or off the road, and is fast, agile and stable in almost any situation. *(AM General)*

RIGHT Military vehicles are built to withstand some degree of overloading, but the weight of the crew and passengers, combined with increasing amounts of makeshift armour, often proved too much for Humvees operating in Iraq and Afghanistan, leading to premature driveline and suspension failures. *(US Department of Defense)*

and I have not seen anything yet that can stop it.' The editor of *Defence* magazine favourably compared the cross-country ride of the Humvee to that of the Land Rover, noting that the former was 'smooth – undulating, but smooth', whilst the prestigious *Off-Road* magazine said that the Humvee was 'state-of-the-art and the finest 4x4 we've ever driven'. Even the *Houston Chronicle* was moved to state that 'this is not your father's Jeep', and it was reported that crews would 'fight over who gets to drive it'.

The driving compartment is surprisingly cramped, but as regards carrying cargo the Humvee easily exceeds the 0.25-ton capacity of the M151, and matches that of the 1.25-ton 'Gama Goat'. Indeed, Al Haas, writing for *Knight-Ridder News*, in a story that was picked up by 61 US newspapers, put it well when he said that 'the Humvee is vastly superior to the Jeep... it has five times the Jeep's payload, and, because of its design, it won't tip over as easily as a Jeep... and can go places a Jeep never could'.

The Humvee also acquitted itself extremely well in Kuwait and Iraq. Robert Dvorchak of Associated Press described it as 'the signature piece of equipment for "Operation Desert Shield"', even if he did also describe it as 'an ugly box contraption with a jaw-breaking name'. Michael P.W. Stone, Secretary of the Army, called it the 'forgotten hero of the Gulf War'; and Senator Dan Coats said that 'the Humvee is performing way above expectations', going on to say that 'the service personnel love it' and that 'the production workers, design engineers and others who had a part in making the Humvee should be complimented'. Other war correspondents said that 'Humvees have been getting high marks for performance... they are reliably delivering the troops and the goods', and that 'the Humvee appears to be winning approval from troops in the Persian Gulf'. Larry Bonko of the *Norfolk Virginian* even went so far as to state that 'the war in the Persian Gulf is the war of the Humvee!'

BELOW Introduced in 1992, and with the manufacturer's loading figure quoted as 2.25 tons rather than the standard 1.25 tons, the M1097 heavy Humvee variant was the first attempt at providing an increased payload capability. *(US Department of Defense)*

Praise indeed... but it is as well to point out that not everyone was equally enthusiastic. Believing that the Humvee was simply too big, the Special Operations Command, 75th Ranger Regiment – a US Army special operations light infantry unit – continued to deploy a fleet of ageing M151A2 'gun jeeps' for various operations. And, whilst the rest of the US Army was singing the praises of the Humvee in the Gulf, the Rangers were casting envious eyes at the British Army's Land Rover Defender-based desert patrol vehicle. In fact they were so impressed by the performance of the vehicle during the liberation of Kuwait that they approached Land Rover with an outline specification for a similar vehicle. The first example was seen in public at the 1992 Eurosatory Show in Paris, and the Rangers took delivery of 60 examples of what was described as the Land Rover special operations vehicle during 1993, operating them alongside a fleet of Humvees.

As the Rangers had so effectively highlighted, if there was a downside, it was the sheer size of the thing – indeed, by 2004, taking a lead from 18th Airborne Corps, who had abandoned the use of Humvees for airborne night operations in restricted areas, many US Army units were preferring, instead, to use the John Deere M-Gator all-terrain vehicle. During 'Operation Anaconda', a seven-day battle with the Taliban in Afghanistan's Shahikot Valley, the 7,000ft (2,300m) altitude of the battlefield precluded the delivery of Humvees by Chinook, but the helicopters were each able to carry two M-Gators and 23 troops.

Usage in combat

But, size aside, there is little doubt that the Humvee was a quantum step forward... and the fact that lessons learned during 'Operation Desert Storm' led only to very minor changes – for example the addition of sun visors – confirms the underlying reliability of the design. The use of run-flat tyre inserts also quickly garnered a following: one Humvee fan, with the 82nd Airborne Division, reported that despite all four tyres being shot out, he was able to drive two miles to safety, probably saving the lives of the six men riding inside.

However, this was not always enough and in certain situations it became very obvious that some form of armoured protection was required.

The up-armoured M1114 proved to be useful in Kosovo and Bosnia during 2001, with around 1,300 vehicles deployed in the two countries. The armour was sufficient to stop most standard rounds, and to provide protection from mine blasts. However, the US Army was heavily committed in several theatres and there were not enough armoured vehicles to go round. In fact, on the eve of the war in Iraq in 2003 just 2 per cent of the fleet of 110,000 Humvees was armoured, and the Army stated that just 235

BELOW Close-up of the severely damaged front end of an M1026 armament carrier that struck and detonated a Serbian TMA-1A anti-tank mine. The Kevlar basic armour would have offered very little protection in this situation, and the vehicle would almost certainly have been considered to be beyond economic repair. *(US Department of Defense)*

RIGHT During a mission readiness exercise, smoke rises from a burning Humvee belonging to 1st Battalion, 30th Infantry Regiment, 3rd Infantry Division, that was hit with a simulated roadside bomb while on convoy during a mock cordon and search of the city of Al-Faraola created at Fort Stewart, Georgia. *(Staff Sergeant Alfred Johnson; US Department of Defense)*

RIGHT These strange half-height armoured doors form part of a field-expedient armour upgrade kit used by the US Marines. The kit also includes large protective armoured panels for the sides of the cargo bay and for the engine cover. *(US Department of Defense)*

armoured Humvees were required in Iraq. By October 2003 it was clear that more armoured Humvees were needed, with the Army stating that the requirement had risen to 3,100 vehicles; a year later the number stood at 4,500.

The fall of Saddam Hussein's regime did not see an end to the need for armoured Humvees, and when lightly protected Humvees started to be used in the patrol and convoy-protection role during the post-conflict period crews turned to almost anything that was to hand in order to provide some measure of armoured protection. Improvised protection included sandbags, scrap steel and Kevlar blankets, and vehicles began to sport features such as improvised steel doors, raised steel side plates and armoured-steel boxes in which a rotating gun pintle could be mounted. Nicknamed 'hillbilly armour', the additional weight of this improvised protection had the effect of overloading and sometimes breaking the suspension, as well as reducing the vehicle's performance to the point where it could scarcely get out of its own way!

BELOW The vehicle already has the supplemental armour, but, no doubt well aware of its shortcomings, and in an attempt at increasing the level of protection, the Marine Corps crew have hung their personal body armour on the outside of the doors. Sandbags have also been stacked on the engine cover. *(US Department of Defense)*

By the autumn of 2003, *The Wall Street Journal* was reporting that armoured Humvees were being reassigned to Iraq from as far away as Korea and by the following January there were said to be 1,200 armoured Humvees in Iraq. Later that year the US Secretary of Defense, Donald Rumsfeld, who had earlier presided over the decision to reduce the production of armoured Humvees, was forced to field a series of awkward questions from National Guardsmen based in Kuwait who wanted to know why they were obliged to improvise their own armoured protection. Although it subsequently transpired that the first question had been posed on behalf of a reporter, nevertheless, the ensuing clamour demonstrated the depth of feeling amongst the

RIGHT US Marine Corps personnel of 1st Platoon, Bravo Company, 1st Battalion, 7th Marine Regiment, arrive at their target objective during convoy operations training at the Marine Corps Air Ground Combat Center. The gunner is firing an M2HB 0.50in heavy machine gun from the roof of an M1043 armament carrier with supplemental armour. *(US Department of Defense)*

men who, daily, were risking their lives using what they believed was unsuitable equipment.

In response to the increased demand, by April 2004, production of the armoured variants at O'Gara-Hess had been increased to around 220 vehicles a month. The Army also appealed to industry to come up with a lightweight armour kit that could be bolted to existing unarmoured vehicles. Production was put in hand at four US Army depots, two arsenals and an ammunition plant, and deliveries of the *appliqué* armour kits started in the autumn of 2004. In 2005 Brigadier General Patrick J. O'Reilly told the US *Army Magazine* that in the previous 18 months somewhere around $400 million had been spent installing Humvee armour in Iraq and Afghanistan. In addition, something like 5,100 armoured Humvees had been delivered to US Army and Marine Corps units in Iraq by the same date in the form of the expanded-capability M1114 and its derivatives.

At the time, the M1114 was the only up-armoured Humvee in full-scale production, with vehicles being produced at a rate of 400–650 per month. However, it became clear that the added weight of the armour placed too much strain on the engine, driveline and suspension components, leading to increased rates of failure, and although the introduction of the M1100 series reliability-enhanced vehicles in 2005 went some way to improving the situation, in the end it must have become abundantly clear that it was a vicious spiral.

Looking back at the AM General press archive for 1984, it seems that Gene Zembrzuski, AM General executive vice president, had been wrong when he declared that 'the Humvee is intended to be a frontline vehicle... it is a fighting vehicle'. The fact is that the Humvee had not been designed as an armoured vehicle – it was not suitable for frontline operations if there was any danger of coming under fire, and no amount of up-armouring was ever going to properly solve the problem.

Production of the M1100 series continued, but in April 2012 Major-General Tony Cucolo, Director of Force Development for the Deputy Chief of Staff G8, signalled that the Army

BELOW This M1038 cargo/troop carrier has been fitted with the supplemental armour doors and is being used by combat engineers to conduct a patrol in search of unexploded ordnance near the town of Bayji, Iraq, in June 2004. The soldiers are assigned to the 1st Infantry Division, 9th Engineer Battalion. *(US Department of Defense)*

ABOVE Typical of the levels of protection required to operate in hostile environments, this expanded capacity IAP armour-ready M1152 is configured as a two-door pickup truck. The standard protection package includes under-body and sill (rocker panel) armour, a deflector at the lower edge of the windscreen, and energy-absorbing seats. Additional perimeter and overhead armour is available, as well as optional 'frag' kits. *(AM General)*

had bowed to the inevitable, stating that 'for combat, we know the Humvee is no longer feasible... [its] future lies in less dangerous missions such as homeland defence, logistics support and other roles that mostly will be performed by the National Guard'. Over the coming years, Cucolo indicated that the Army would begin to phase out the Humvee from 'combat inventories'.

Replacement

It is difficult to believe that the Humvee is approaching its 30th birthday, and whilst it has probably performed beyond expectations in many respects, the changing nature of the conflicts in Iraq and Afghanistan has tended to highlight its shortcomings, specifically with regard to crew survivability when exposed to improvised explosive devices, and the ability of the increasingly heavily armoured Humvee to carry a useful tactical payload. It was not originally designed as an armoured vehicle, and the need for armour has resulted in compromises in all-round performance.

In 2006 the US government announced that it had started the process of developing a Humvee replacement, effectively from scratch. Described as the 'joint light tactical vehicle' (JLTV), and embracing both armoured and soft-skin variants, the work is a joint effort between the US Army, the US Special Operations Command and the US Marine Corps. It is planned that the JLTV will cover a range of roles including reconnaissance, infantry combat vehicle, command vehicle, armoured utility vehicle and cargo truck.

Initially, the following companies and partnerships were involved in bidding for the JLTV contract: Boeing, Textron and Millenworks; General Dynamics and AM General, operating as General Tactical Vehicles; Force Protection and DRS Technologies; BAE Systems and Navistar; Northrop Grumman, Oshkosh Truck and Plasan; Lockheed Martin, BAE Systems, Alcoa Defense and JWF Industries; and Blackwater and Raytheon. In March 2012 the number of vendors was reduced to nine, and in August, the Army and Marine Corps selected three companies, Lockheed Martin, General Tactical Vehicles, and BAE Systems/Navistar, to compete for the JLTV production contract.

ABOVE AM General and General Dynamics Land Systems have formed a joint venture named General Tactical Vehicles to compete for the US Army and Marine Corps joint light tactical vehicle (JLTV) programme. *(AM General)*

LEFT BAE Systems, together with partners Meritor Defense and Northrop Grumman, are also competing for the JLTV programme with their Valanx vehicle. *(BAE Systems)*

ABOVE The third competitor for the JLTV programme is Lockheed Martin. In August 2013 a total of 22 vehicles were delivered to the US Army and Marine Corps for testing. *(Lockheed Martin)*

In announcing that the JLTV development programme had entered the engineering and manufacturing development (EMD) phase, Tank-Automotive and Armaments Command (TACOM) stated that each of the three companies had been awarded contracts worth between $35.9 million and $45 million to build 22 prototype vehicles over a period of 27 months. The vehicles produced for the EMD phase of the programme were due to begin deliveries in spring 2013, with the ultimate winner to be selected following service trials.

Production is planned for 2015/16, with 50,000 vehicles intended for the US Army and 5,000 for the Marine Corps. This will result in the Army's 260,000 Humvee fleet being reduced by 15 per cent by 2017, with the Marines reducing their fleet of Humvees from 44,000 to 32,500. However, don't imagine that this will mark the rapid demise of the Humvee – a committee report produced for Congress in 2012 suggested that 'the Services will continue to operate significant numbers of Humvees for at least another 20 years'.

AM General has also shown interest in the US Army's Special Operations Command Ground Mobility Vehicle (GMV-1.1), putting forward as a possible contender a much-modified M1100 series Humvee, powered by a six-cylinder Optimizer 3200 engine.

Service with other military users

The Humvee has proved to be enormously successful, and, as well as being in service with the US Army, Air Force and Marine Corps, somewhere around 25,000 examples have been supplied under the US foreign military sales scheme, a government-to-government programme for selling defence equipment, services and training to 'friends and allies' of the USA. Under this scheme, the US government procures defence articles and services on behalf of the foreign customer, and countries approved to participate in the scheme are able to purchase these items using national funds, or with funds provided through US government-sponsored assistance programmes.

The Humvee is currently in use in more than 65 countries across the world, including the armies of Afghanistan, Albania, Algeria, Argentina, Bahrain, Bosnia–Herzegovina, Bolivia, Botswana, Bulgaria, Canada, Chad, Chile, China, Colombia, Croatia, Czech

LEFT Moroccan Army M998A1 cargo/troop carrier forming part of the SFOR peace-keeping mission in Bosnia-Herzegovina in 1998. *(Carl Schulze)*

Republic, Denmark, Djibouti, Dominican Republic, Ecuador, Egypt, El Salvador, Ethiopia, Georgia, Greece, Honduras, Hungary, Iraq, Israel, Kazakhstan, Kuwait, Jordan, Kenya, Latvia, Lebanon, Lithuania, Luxembourg, Macedonia, Mexico, Monaco, Mongolia, Montenegro, Morocco, Nepal, New Zealand, Oman, Panama, Peru, Philippines, Poland, Portugal, Romania, Russian Federation (seized from Georgia), Saudi Arabia, Serbia, Slovakia, Slovenia, Spain (with the police service), Sudan, Tanzania, Thailand, Tunisia, Uganda, Ukraine, United Arab Emirates, Venezuela, Yemen and Zimbabwe.

The case of Iraq is particularly interesting, with the US government gifting a total of 8,500 refurbished M1114 variants under a two-year transfer scheme during 2008 and 2009. Similar numbers of vehicles will almost certainly be left with the Afghan National Army when the US Army finally withdraws combat units from the area in 2014; at the time of writing (summer 2013) some 950 rebuilt and renovated vehicles, also including up-armoured M1141 variants, had already been supplied to Afghanistan under a foreign military sales case.

Locally built versions are also in service in the Republic of China, Greece and Mexico.

BELOW LEFT With all hatches and doors open, this Polish Army M1026 armament carrier sports a roof-mounted weapons station with the gunner shield kit. *(Stefan Marx)*

BELOW The same vehicle with the doors and hatches closed. *(Stefan Marx)*

ABOVE **Winch-equipped M1114 expanded capacity up-armoured armament carrier of the Iraqi Army photographed in Baghdad, February 2007. Note the damage to the right front corner of the engine compartment cover.** *(US Department of Defense)*

BELOW **Belonging to the United Arab Emirates Army, this M1025A1 was photographed in Kosovo in 1999. Note the jerrycan stowage and the rear-mounted spare wheel.** *(Carl Schulze)*

BELOW **Afghan Army winch-equipped M1097 shelter carrier fitted out for use as an ambulance.** *(Carl Schulze)*

ABOVE **M1114 of the Slovenian Army photographed during 'Exercise Peacemaker 2007'. The square tubing bracket in the centre of the bumper is designed to hold a wire cutter.** *(Carl Schulze)*

ABOVE **Battered M1152 of the Afghan Army carrying an armoured shelter that has been equipped with a pair of weapons stations. The photograph was taken in Mulkanah village, Kunar Province, in January 2012.** *(Sergeant Trey Harvey; US Department of Defense)*

BELOW **Mongolian Army M1151A1 photographed at Kabul International Airport. The vehicle is fitted with the 'objective gunner protection kit', as well as additional armour.** *(Carl Schulze)*

BELOW **Iraqi Army soldiers convoy out of Baghdad, Iraq, after a city council meeting held in January 2007. The grilles at the rear of the lead vehicle identify this as an M1114 that has been fitted with 'frag' kits 1 and 1A.** *(Staff Sergeant Antoine T. Robinson; US Department of Defense)*

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'Although re-utilisation, transfer and disposal is permitted, sales of Humvees in their original military configuration are not permitted... vehicles not released through the re-utilisation, transfer and disposal scheme will be mutilated in a manner that prevents reassembly as a usable vehicle.'

US Department of Defense: *Defense Materiel Disposition Manual*

Chapter Six

The owner's view

The Humvee has now been in production for almost 30 years, with the total number of vehicles manufactured running close to a quarter of a million, so it would seem logical to assume that older examples would have started to appear on the military surplus market and that the vehicle would be a common sight at military-vehicle rallies. However, this is not the case, and Humvees in private hands still remain a relatively rare sight.

OPPOSITE Outside of the USA, you would be very lucky to spot more than one Humvee at a military vehicle show ... the exception, of course, being the massive annual 'War & Peace Revival' event. *(Phil Royal)*

ABOVE Formerly the property of the US Marine Corps, this M1044, with supplemental armour, sports a weapons station with the gunner shield kit, high-level air intake and exhaust systems and a front-mounted winch. *(Jim Alexander)*

Buying a Humvee

The reasons for the scarcity of Humvees in the hands of enthusiasts are twofold. Firstly, the current policy of rebuilding ageing Humvees means that few are considered to have reached the ends of their lives; but the major stumbling block would appear to be the US Army's attitude to disposal, which has led to a situation whereby Humvees have been constructed in their thousands, but older vehicles are not generally being made available to the public.

US Army disposals policy

A lack of niceties such as a 'park' position for the automatic transmission (M998 and M998A1 series), and a similar lack of reversing lights, mean that the Humvee does not comply with current US Department of Transportation legislation covering vehicle construction and use. Similarly, there are no airbags, side-impact protection, internal padding or impact-absorbing surfaces, which means that it is compromised in terms of occupant and pedestrian safety. For these reasons, in theory at least, the Humvee cannot be registered for

RIGHT Mounting dummy H2B 0.50in heavy machine guns, this pair of ex-Marine Corps M1026 armaments carriers were photographed in the 'War & Peace' arena in 2012. The lead vehicle also has the high-level air intake that allows deep-water wading. *(Phil Royal)*

use on the road in the USA, and any vehicles that are sold at auction are either damaged beyond repair and described as 'scrap', or must be crushed and cut. A US Department of Defense document entitled *Defense Materiel Disposition Manual* clearly states that, although 'reutilization, transfer and disposal (RTD) is permitted, sales of Humvees in their original military configuration are not permitted ... the Defense Reutilization and Marketing Service (DRMS) may pursue sales methods aimed at bringing these vehicles up to Federal Motor Vehicle Safety Standards ... [but] vehicles not released through the reutilization, transfer and disposal scheme will be mutilated in a manner that prevents reassembly as a usable vehicle.'

Despite the end of both Humvee production and the recapitalization programme, and the announcement that the joint light tactical vehicle (JLTV) will start to replace the Humvee in US Army and Marine Corps service from 2015, there is no evidence that this situation is likely to change... but it does make one wonder just what will happen to thousands of surplus US Army Humvees when deliveries of the JLTV start.

A few vehicles slipped out 'under the radar' in the early days, more than one to companies engaged in cleaning up hazardous waste sites, but government policy ensured that surplus Humvees rapidly became nigh on impossible to obtain. However, all this changed in 1999, when the US Marine Corps disposed of around 750 used Humvees through United Defense in exchange for new equipment. These vehicles made their way to Manheim Auction Services, with the first auction sale taking place at Atlanta, Georgia, in August 1999, and a second later that year in California. Around three-quarters of the vehicles offered for sale were sold, at prices ranging from $14,000 to $27,000, and a large number ended up in the hands of dealers, exporters and collectors. The successful bidders received a copy of US government form 97 transferring ownership to United Defense and an invoice from Manheim stating that the vehicle was being sold for 'off-road use'.

ABOVE Seen at the Virginia Museum of Military Vehicles, this M1025 armament carrier presents an almost factory-fresh appearance. Like most ex-Marine Corps vehicles it sports the high-level air intake. *(David Doyle)*

LEFT The strict rules governing disposal of used Humvees ensure that very few come up for sale on the collectors' market. This M1025 was spotted carrying a 'for sale' sign at a military vehicle show – but you need to be quick and have deep pockets. *(Simon Thomson)*

However, it seems that there were anomalies in the paperwork that made it possible to obtain legitimate title sufficient to allow the vehicles to be registered for the road – at least in some states of the USA. These ex-Marine Corps vehicles remain available on the collectors' market, albeit at a considerable price.

Finally, whilst the original terms of the sale may have specifically forbidden it, there is also a chance that it might be possible to acquire a surplus Humvee that was formerly supplied to a foreign government under the US Department of Defense's foreign military sales programme.

And don't imagine that it would be cheap to buy a civilian Hummer H1 and 'militarise' it... good examples can change hands at up to $100,000.

Importing a Humvee

Under the UK Ministry of Transport's Individual Vehicle Approval (IVA) scheme, it should be possible to import a Humvee and to submit it for what used to be described as 'single vehicle approval' (SVA). Both the SVA and the IVA schemes have been devised to ensure that vehicles that have not been type-approved in Britain are designed and constructed to a satisfactory standard. An imported vehicle cannot be road-registered unless it has been approved.

Issues that might result in difficulties during the test include the configuration of the military lighting system, as well as the lack of high-level brake lights, a lamp over the rear number plate, side lights and a reversing lamp, and it may be necessary to retrofit these lights. There may also be a problem with the fact that the front seats, of early vehicles at least, are fitted only with two-point lap straps. Take a look at www.gov.uk/vehicle-approval/single-vehicle-approval.

What to look for when buying

The scarcity of Humvees available on the collectors' market gives considerable advantage to a seller, and it is unlikely that any buyer will have a choice of more than four or five vehicles at any given time. Whilst most buyers would choose to walk away from a vehicle that exhibited symptoms such as a noisy engine or smoky exhaust, or one that was hard to start or which was reluctant to change gear, the shortage of vehicles available might mean that there is little choice.

Similarly, the small number of vehicles currently available generally precludes the possibility of finding vehicles that are incomplete or otherwise ripe for restoration. The good news is that the engine and transmission, at least, are also used in other military and commercial vehicles and

RIGHT The US Army does not currently sell used Humvees to the public, even when beyond economic repair. The situation may change when deliveries of the JLTV start in 2015, but at present there is no indication that this is the case. *(US Department of Defense)*

remain relatively easily available – and rust will not generally be an issue. However, it is not quite the same story with those parts that are unique to the Humvee. Parts are not necessarily impossible to find, but it is not always going to be easy, so if you really feel that you can't live without one, you should make sure that the vehicle you buy is as complete as possible.

It would also be prudent to check that the vehicle is adequately titled and that it will be possible to register it for use on the road.

In Britain, the weight of the Humvee might create problems when submitting the vehicle for the statutory roadworthiness test (MoT test). The old exemption for all-wheel-drive 'dual-purpose vehicles' that allowed even the largest Land Rovers to be tested under the Class 4 rules was withdrawn in 2009, and the current MoT regime says that if the vehicle weighs more than 3,000kg, and up to and including 3,500kg design gross weight (DGW), then it will require the Class 7 test. The same list of issues that could cause problems during the IVA examination might well arise during MoT testing: for example, a lack of high-level brake lights, a lamp over the rear number plate and a reversing lamp; the military lighting system; and the two-point lap straps fitted to early examples. Much depends on the individual tester.

In the USA, some of these same issues, as well as the lack of a collapsible steering column and a distinct lack of crash padding on the fascia, may also result in a failed safety inspection. Some states are apparently more accommodating than others in this respect.

Humvee ownership in other countries will inevitably present its own problems.

Mechanically, the Humvee is extremely robust, but check that the diesel engine does not emit excessive smoke, indicating that the need for a rebuild is imminent, and that the transmission operates correctly. Check the tyres for signs of uneven wear that might indicate that something is amiss with the alignment of the steering or suspension.

Price

As with any market commodity, the combination of scarcity and demand has resulted in prices rising since those Marine Corps vehicles were auctioned back in 1999, and remaining high since.

ABOVE Very tidy privately owned ex-Marine Corps M1043 that has been fitted with the Ibis Tek reinforced pusher bumper, high-level air intake, and weapons station with gunner shield kit. Note also the bumper-mounted infrared lights. *(Simon Thomson)*

In the USA, exceptional vehicles have been known to change hands at close to $50,000: recent examples available for sale have covered the price range $30,000 to $44,000. You should expect to pay a low of $4,000 for a very incomplete or damaged vehicle fit only for parts, should you be able to find one, and between $10,000 and a high of around $35,000 or more for a vehicle that is complete and usable, depending on condition.

Elsewhere, expect to pay the local currency equivalent of these prices, or a bit more, since outside of the USA the scarcity effect is even more pronounced. At the time of writing (summer 2013), two or three examples are available on the international military-vehicle collectors' portal Milweb (www.milweb.net). One of these was in Germany priced at 32,900 Euros, and one in France for an undisclosed price, with both of these for sale through dealers; the third was in Britain, being offered in a private sale for the 'best offer over £38,000'.

At least for the present, Humvee ownership remains the preserve of the better-off enthusiast.

Originality

It is very unlikely that any Humvees will have undergone civilian modification beyond that which might be required to operate legally on the road, so there should be no questions

RIGHT The lack of availability of Humvees on the civilian market and the relatively high price of those vehicles that are available has led to the appearance of a number of replicas and lookalikes. This is the Australian-built Rhino Buggy Hammer H1 (www.rhinobuggies.au.com), priced from around $15,000 (Aus) in kit form. *(Rhino Buggies)*

regarding 'originality'. No one could argue that the condition and state of modification in which the Humvee was discharged from service is anything other than 'original'.

Wherever possible, any subsequent modifications or additions to the vehicle should be made using age-appropriate components of US military origin. You must make up your own mind about how far you want to go, but the use of civilian parts will almost certainly reduce the value of the vehicle. And remember, no military vehicle should be fitted with, for example, civilian indicators or generic after-market parts.

Replicas

The combination of demand and scarcity has inevitably ensured that Humvee prices remain high. A side-effect of this has been the emergence of the Humvee replica. Companies such as Urban Gorilla (www.4x4bodies.com), Rhino Buggies (www.rhinobuggies.au.com) and Tremor MUV (www.tremormuv.com) produce examples of kits of varying authenticity, and at a range of prices. Just don't expect the same levels of performance as the original.

Restoration

The process of restoration involves dismantling a vehicle right down to its individual parts and then replacing or repairing all worn, corroded and damaged components before reassembling the parts to present the vehicle in 'as new' or, often, 'better than new' condition. Many of the processes involved will be common to all types of vehicle, and, fortunately, mechanical components such as the engine and transmission of the Humvee are shared with other, commercially-available vehicles which will simplify any necessary mechanical repairs. The Humvee presents no particular problems in dismantling, although some aspects of the vehicle's design and construction – such as the bonded and riveted aluminium body, the inclusion of electronic diagnostic facilities, the central tyre-inflation system (CTIS) and the use of potentially toxic chemical agent resistant coatings (CARC) – will present special challenges to the restorer more familiar with older machinery.

At the time of writing (summer 2013), a well-restored Humvee can cost upwards of £35,000. Nevertheless, it is almost always the case that the cost of restoring a poor example – as with any vehicle – will exceed the cost of buying one that has been well restored by someone else. For this reason, it is always good advice to buy the best example that you can afford and let the previous owner bear the cost of restoration... this is particularly true in the case of the Humvee, where restoration may well prove to be a costly business. However, the real problem is that anyone wishing to carry out a restoration will find that few genuine candidates are available.

In recent years the trend has been towards purchasing vehicles in what could be described in this context as original 'ex-motor pool' or 'ex-theatre' condition. This would mean that the vehicle is complete and in near-to-full working order, still with its original paintwork, but with the damage, wear and battle scars picked up during a lifetime of honest hard work in the hands of one probably not very careful owner. During any restoration process it is impossible to maintain any links that the vehicle has with its service past, so if the vehicle remains sound and still has many of its original features, give serious consideration to maintaining it in that condition.

If you feel that you must restore and are keen on maintaining a genuine 'military' appearance, be wary of over-restoration. Unnecessarily fussy detailing is an absolute 'no-no', and when trying to decide how the vehicle should be finished and detailed, try to study some military vehicles that have been in service for some time. Note particularly the often indifferently applied paint, usually in multiple coats, and the general lack of attention to detail.

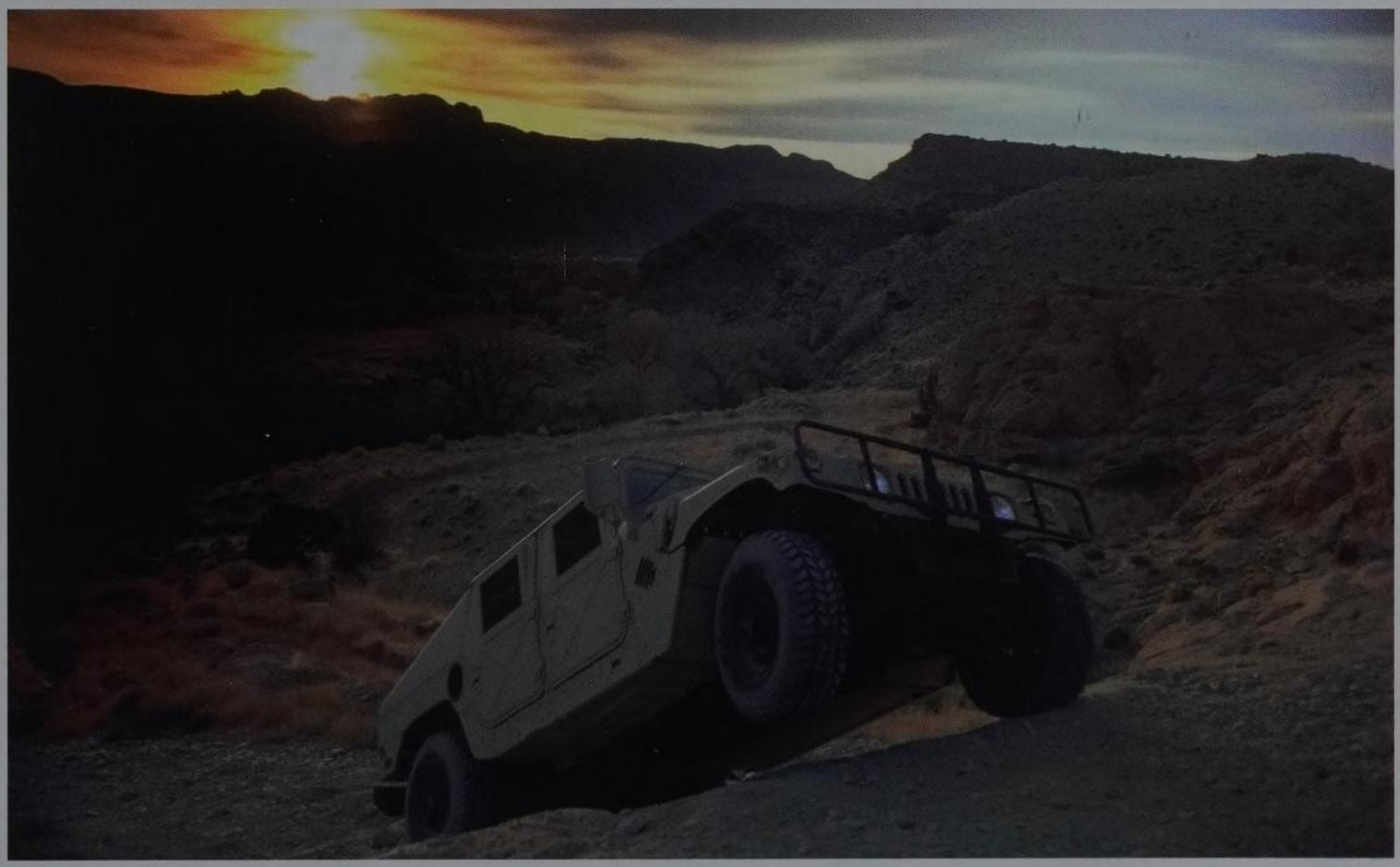
Driving and using the Humvee

Driving a Humvee should present no particular problems. Forward visibility across the sloping engine cover is excellent, and, with plenty of low-down torque and a maximum speed on the road of around 70mph (113kph), the vehicle is well able to keep up with motorway traffic. Other standard features, such as power steering, automatic transmission and servo-assisted brakes, also help to take most of the physical effort out of driving the Humvee. Indeed, back in 1991 AM General's Craig MacNab said that 'your grandmother could easily drive the thing to the supermarket... and it's [also] an unbelievable off-road machine'.

LEFT Being pretty much unstoppable, driving a Humvee off the road can be an exhilarating experience ... always provided, that is, that you are not actually being shot at! *(Warehouse Collection)*

LEFT Photographed on a New York street in 1989, this M998 is configured as a two-door pickup with a high rear cover. The sheer width of the thing means it is probably less at home in the somewhat narrower streets found in Britain. *(Warehouse Collection)*

BELOW Having one wheel off the road, even when climbing, presents little difficulty... the combination of torque-biasing differentials, plus a centre differential, allows the vehicle to lose traction at three wheels without becoming immobilised. *(AM General)*



ABOVE Whilst occupants may have complained to AM General that the interior is not entirely waterproof, the automotive components fare considerably better. Even without the deep-water wading kit, the electrical and intake systems are sufficiently protected to allow the Humvee to wade to a depth of 30in (762mm). *(AM General)*

BELOW Despite the use of torque-biasing differentials, if all four wheels lose traction forward motion will cease and it will be necessary to find a tow. *(US Department of Defense)*

In fact, this is almost an understatement. Off the road the machine is virtually unstoppable and it is not unusual to hear first-time drivers describe the Humvee's off-road capabilities as 'stunning' or 'awesome'! The automatic transmission makes off-road driving particularly easy, and the transfer case settings allow most types of terrain to be tackled with confidence. There are two 'high' settings, one of which (HL) includes the ability to lock-out the centre differential to improve traction in wet or frozen snow or mud, whilst the 'low' setting improves traction by reducing the overall gear ratios as well as locking-out the centre differential. There is also a neutral position to the transfer case to allow a disabled vehicle to be towed without any need to disconnect the driveshafts.

Fully loaded, a Humvee can easily climb inclines of up to 60 per cent and safely traverse side slopes of 40 per cent without danger of overturning, and the approach and departure angles are excellent. The optional central tyre-inflation system (CTIS) also allows the traction offered by the big, low-profile radial tyres to be adjusted to suit changing terrain, whilst independent suspension helps to keep all four

wheels firmly in contact with the ground. And full-time four-wheel drive, combined with torque-biasing differentials, means that the technique of brake and throttle modulation will allow progress to continue to be made even with traction available at just one wheel. If any wheel loses traction, the action of touching the brake pedal momentarily will lock the differentials and redistribute the power equally to all four wheels.

Nevertheless, US Army training manuals are at some pains to point out that the Humvee is 'not a high-speed/high-mobility vehicle... it is a high-mobility vehicle that requires the operator to keep all four wheels on the ground'!

In private hands the Humvee is no more or less safe on the road than other SUVs of similar size and, indeed, it could be argued that its wide stance and low centre of gravity would tend to increase off-road stability. However, in combat areas there is an ever-present threat of encountering a roadside bomb that might overturn the vehicle and necessitate a forced exit. In fact, so real is this possibility that Precision Products Inc has devised what is described as the 'HMMWV egress assistance trainer' (HEAT), capable of a full speed-controlled 360° controlled rotation. Designed to replicate in-theatre operations in a safe and controlled environment, the HEAT facilitates training for emergency evacuation, self-aid and removal of injured personnel in the event that a vehicle should become inverted or roll onto its side.

On the road, it is a slightly different story and the ride will be found to be harsh and very noisy, with a fair degree of mechanical racket. The steady drone of the big diesel up front is accompanied by a howling from the transmission, the hub reduction gears and the tyres, suggesting that the use of ear defenders is not a bad idea. Indeed, military documentation suggests that for M1097 and all A1 and A2 model vehicles, hearing protection is required for both the driver and passengers when the engine is running, since the noise levels produced by these vehicles exceed 85dBA, 'which may cause injury to personnel'.

Inside, there is little in the way of creature comfort. Few of the internal surfaces are padded or insulated against noise. The plastic-covered seat cushions are thin, and although the seats fitted to 'A2' and 'A3' variants are high-backed, none offer much as regards proper lumbar support, and what lateral restraint is provided comes by courtesy of the seat belts, the transmission tunnel and the doors rather than from the seat itself.

It is also not especially comfortable, particularly in the original M998 series where the seat cushions were particularly meanly specified. Perversely, bearing in mind the size of the thing, the driving seat is small and the distance between the two front seats is vast, the driver and passenger being separated by a huge transmission tunnel that is wide enough to be used as a support for a radio set. Both of these factors, combined with a tiny 14in (355mm) steering wheel, add to the perception of width, as well as contributing to the feeling of the cockpit being rather cramped. Drivers over 6ft 4in (1.93m) in height may also find the driving position cramped in a two-door vehicle.

At least there is a standard heater/defroster unit fitted, as well as an optional air-conditioning system or 'arctic kit' for use in more extreme environments.

But, putting aside all notions of handling and comfort, to European eyes at least the real problem with driving the Humvee is one of size – it is certainly no Jeep! And in Britain this is not helped by the fact that, since all Humvees are left-hand drive, access to toll booths and car-park ticket machines will be impossible without leaving the vehicle. Measuring 86in (2,185mm) across the tyres, the Humvee is an extraordinarily wide machine, and whilst it

BELOW This M1043 has been equipped with snow tracks at each wheel station which, although doing little for the steering and handling characteristics, certainly give the vehicle an edge in deep snow. *(Lance Corporal E.J. Young; US Department of Defense)*

might be fine on wide highways and in locations where the terrain is open and there is no road at all, it is not well-suited to the confines of narrow lanes, and the driver is obliged to keep a careful eye on his flanks. Rear vision is also poor, with a huge blind spot.

However, the Humvee is certainly going to attract a lot of attention, both on the road and at any military vehicle show. And, at all but the largest shows, the lucky owner will almost certainly find that he has the 'Humvee class' all to himself... although, having said this, enthusiast and collector Rick Forys, writing in the Military Vehicle Preservation Association's (MVPA; www.MVPA.org) bi-monthly *Supply Line* publication in mid-2013, was moved to observe that the 40th East Coast Rally at Aberdeen, Maryland, was the first time that he had 'seen more Humvees than Jeeps!'

Safety

It is probably true that the safety of neither the occupants nor any luckless pedestrians that the vehicle might run into was high on the Humvee design team's list of priorities. As regards passive safety systems, early examples were fitted with nothing more than a non-locking lap-strap, and whilst a proper three-point seat belt was fitted to later variants there are no airbags, nor any proper crash padding, and although the A and B pillar posts provide some degree of support in the event of the vehicle rolling they are no substitute for a proper roll-over protection system. But in this respect the Humvee is no worse, and in some cases considerably better, than most surplus military vehicles.

Although this will hardly be of any concern to the average private owner, US Army manuals suggest that, in the interests of safety, the operator should remove a 'billfold' (wallet) from the rear pocket, as well as removing any 'pistol belt, canteen and protective mask... especially during off-road operations, since the latter can put pressure on the spine'.

RIGHT Soldiering is a hazardous enough business at the best of times, without inviting avoidable injury... which might explain why the Humvee, like all modern military vehicles, carries every conceivable kind of warning. *(Simon Thomson)*

Potential operating hazards

In common with most Western nations, the USA has warmly embraced the 'health and safety' and compensation cultures, and Humvee official documentation is liberally seasoned with alarming warnings of impending disaster. Here are a few:

- Never open one end of the cargo-shell door without first ensuring that the opposite end is securely closed. Not doing so may cause both ends to open at the same time, causing damage to the equipment.
- Do not handle the winch cable with bare hands – always wear leather gloves. When fully extending the winch cable, ensure that four wraps of cable remain on the drum at all times.
- Stand well clear of the cable during winch operation.
- Wrap a blanket, coat or chain over the winch rope to act as a damper should the anchor fail or the rope snap.
- Do not use the hand throttle as an automatic speed or 'cruise control' – it will not disengage when the brakes are applied.
- Do not use bias-ply tyres on the M1097, or on any 'A1' or 'A2' series vehicles.
- Do not operate the vehicle without the windshield assembly in the upright position, and the B pillar securely attached.
- If, during wading operations, water should enter the engine, the oil should be drained and replaced and the water expelled by cranking the engine with the glow plugs removed before any attempt is made to restart.

FAR LEFT **Even starting the engine whilst operating the radio is considered to be a hazard.** *(Jim Alexander)*

LEFT **In Iraq and Afghanistan it is also necessary to issue warnings to civilians – approaching too close is presumably interpreted as a hostile act in an environment where the good guys and the bad guys are often indistinguishable.** *(Simon Thomson)*

- After wading operations, the brakes may operate unevenly. Keep applying the brakes lightly until the vehicle pulls up in a straight line.
- Remember that there is no roll-over protection for passengers carried in the rear of the vehicle.

Reliability

Despite reports that overloaded and overheated Humvees on front-line duties 'regularly break down and require an engine change after only 1,000 or 2,000 miles (1,620 or 3,240km)', in civilian service these kinds of problems can generally be disregarded. Overloading is also particularly hard on the suspension and drivetrain components and tyres, but when treated with respect, and when driven regularly, the Humvee is an extremely reliable machine. However, it is also as well to remember that this is not a World War Two Jeep and, if something does break, it is generally going to be expensive to fix. The use of modern electronics means that many failures, and even overheating of the engine, will put the engine control unit (ECU) into 'limp-home mode'.

Early versions of both the 6.2-litre and 6.5-litre engine acquired a reputation for cracks in the main bearing web; this was remedied by altering the chemical composition of the casting material. Engines with a high mileage can also exhibit cracks in the cylinder head, and there are stories of blown head gaskets and cracked engine blocks.

In the early days there was also said to be a continuing problem with the ball joints in the suspension arms, with the joints on some vehicles said to be failing at around 12,000 miles (20,000km). The original ball joints were welded, stamped steel housings with a Teflon-lined cup, but when the vehicle was driven hard in an off-road situation the housing proved to be insufficiently strong to survive the continuous pounding, and the welded section would fail. The problem was solved by replacing the original joint with a redesigned component that used a forged body, and the service life of these forged joints has been tested to be 35,000 to 45,000 miles (56,000–73,000km).

There are reports on the Internet of electrical-system failures, and even fires, caused by arcing at the bolt that makes the earth connection from the current shunt in the battery box, through the transmission hump to the earth cables under the truck. Other reported problems include many instances of failure of the printed circuit boards in the Prestolite control box, often caused by water ingress, and in heavy off-road use the body-mounting bolts can work loose. Finally, breakage of the small brackets that support the air-conditioning condenser units will cause a failure of the condenser itself.

BELOW **For the military, roadside breakdowns can be hazardous. For the civilian, in a privately owned vehicle, a breakdown is, at best, inconvenient. Here, a US soldier makes emergency repairs to his Humvee during a civil affairs mission in Baghdad, Iraq.** *(US Department of Defense)*

ABOVE **Where mere seconds can make the difference between life and death, it makes sense to have a tow rope ready for use should a breakdown occur.** *(US Department of Defense)*

ABOVE RIGHT **Towing a vehicle with an automatic gearbox normally requires the drive to the wheels to be disconnected... the Humvee has a neutral position in the transfer case to allow a disabled vehicle to be towed without further mechanical attention.** *(US Department of Defense)*

RIGHT **If you are in the fortunate position of owning two Humvees, then, should the worst happen, you can always use one to push the other! Here US Army personnel push an immobile vehicle to safety on a convoy retrieval exercise at Memorial Range, Tikrit, Iraq.** *(Jeremiah Green; US Department of Defense)*

RIGHT **Personnel of the US Army, 2nd Armored Cavalry Regiment, based at Fort Pope, Louisiana, maintain a defensive posture around their convoy, as a fellow soldier climbs into the engine compartment to make emergency repairs to an M1026.** *(US Department of Defense)*

LEFT Although features such as power steering and automatic transmission make the Humvee easy to drive, the US Army nevertheless takes driver training very seriously. Here, students in the Air Force Advanced Contingency Skills Training Course prepare to move out as part of a convoy operations class at Fort Dix, New Jersey, 2007. *(US Department of Defense)*

Body-wise, the roof hatches tend to leak in heavy rain, but, as an AM General spokesperson put it, 'we make them bullet-proof, not waterproof!'

Maintenance and repairs

It is as well to remember that no matter how keen, none of the motorists' roadside assistance services are going to be able to offer you much help in the event of an emergency. What's more, the size and weight of the vehicle may also present recovery problems with the standard 'domestic' roadside rescue services.

Even a puncture will present a problem, since few of the US Army Humvee variants carry a spare wheel and only 'A2' and 'A3' variants are routinely equipped with run-flat tyres – and in what could well be 'the worst job in the world', US Army mechanics report that breaking-down a wheel to replace a tyre that has been run flat on the magnesium insert is unpleasant in the extreme. As the tyre collapses, a lubricant is released to prevent overheating and this 'black oily goo' apparently gets 'all over everything' and is very difficult to remove. With the appearance of the 'A2' variant in 1995 a change was made to rubber bead-lock inserts that both obviated this problem, and provided greater mileage when running deflated.

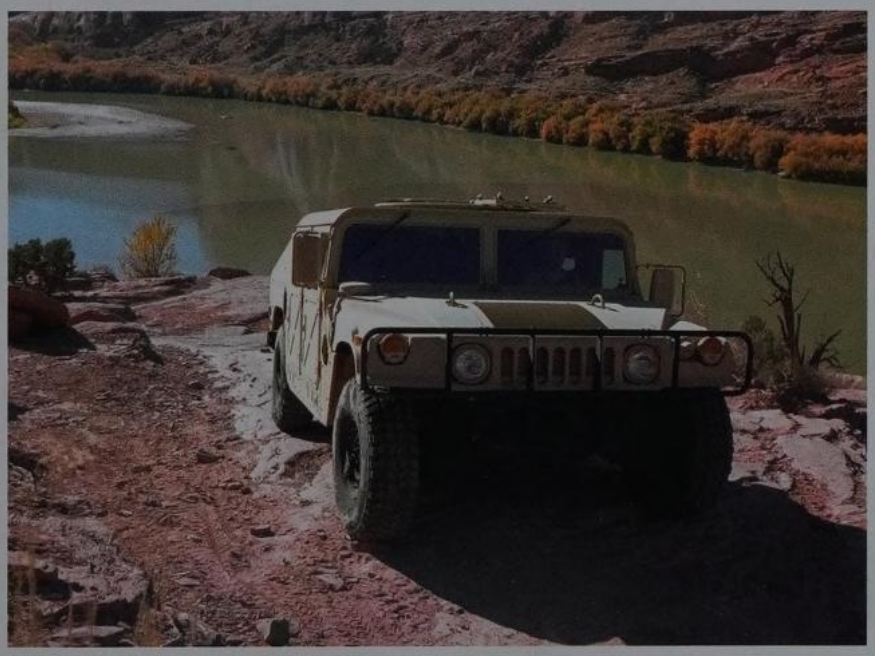
Values and insurance

Whilst 'past performance is no guarantee of future results', those few Humvees that have appeared on the surplus market have proved to be less of a financial investment than might have been hoped. Prices have certainly held firm since 1999, but they have not shown the same levels of growth as, for example, Jeeps or World War Two armour. In view of the scarcity of examples for sale, this is slightly surprising, but if no more become available over the next few years prices are certain to rise.

At the time of writing (summer 2013) a realistic budget for a good, usable Humvee is around $30,000–50,000, or the same amount in pounds sterling.

Special, low-cost insurance schemes exist for all ex-military vehicles, but be careful that the vehicle is covered for its full replacement value, including accessories and spare parts. Should there be a total loss, you should also make sure that the insurance company will allow you to buy back or retain title to the wreckage.

BELOW Equally at home on or off the road, the Humvee can take rocks, loose soil, sand and water in its stride. Whilst pointing out that 'your grandmother could easily drive the thing to the supermarket', AM General's Craig MacNab also pointed out that 'it's an unbelievable off-road machine'. *(AM General)*



'The best way to maintain vehicles covered by this manual is to inspect them on a regular basis so minor faults can be discovered and corrected before they result in serious damage, failure, or injury.'

US Army: TM 9-2320-280-20-1; Technical manual – unit maintenance; January 1990

Chapter Seven

The mechanic's view

Although the front-hinged cover opens wide, the engine bay is crowded, and access – at least to the rear of the engine – is not at all easy unless the internal access panel is removed. It is often necessary to almost climb into the engine compartment. Should the worst occur, and the engine need to come out, US Army mechanics reported that it requires 16 man-hours to remove and replace a Humvee engine. Compare this to less than two hours' work for the World War Two Jeep!

OPPOSITE US Marine Corps Lance Corporal Stephen G. Stryburg, kneeling, a mechanic with Combat Logistics Company (CLC) 19, shows Iraqi soldiers how to perform routine preventive maintenance checks and service on a Humvee. *(Sergeant Jason W. Fudge; US Department of Defense)*

LEFT US Marine Corps Corporal Justin Loper, 22nd Marine Expeditionary Unit, examines an overheated Humvee engine during a brief convoy halt. If parts are required to effect a repair, help should never be far away. *(US Department of Defense)*

Safety first

It hardly needs to be said that any motor vehicle can bite, and bite hard, if treated without sufficient respect. Even during maintenance and repair operations there are all kinds of potential perils, some of which can result in serious personal injury.

Personal protection

- Before starting work, make sure you are wearing proper mechanic's overalls and stout boots or shoes, preferably with steel toecaps. Tuck any loose hair, neckties or other clothing out of harm's way. Remove rings or other jewellery to avoid the possibility of causing accidental electrical short circuits.
- Never work under a vehicle that is not properly supported on axle stands. A jack does not provide safe support.
- The automatic transmissions on M998 and M998A1 series vehicles do not have a 'park' position. Whenever the vehicle is parked, or the transmission is in neutral, the parking brake must be applied.
- Keep your hands and fingers away from the fan when the engine is running. Be particularly wary of electric fans, which can start without any warning.
- Remember that the exhaust system and radiator become very hot when the engine is running and can cause skin burns.
- Do not attempt to lift heavy components without adequate assistance. A good rule of thumb is to not try to lift more than 120lb (55kg) single-handedly. The figure should be reduced if the load is awkward or sharp edged, or if it needs to be held at arm's length, or if you are forced into an uncomfortable working position.
- Wear suitable eye protection when using a grinding wheel or powered abrasive discs, etc.
- Do not strip paints and surface coatings without proper respiratory protection. The

chemically resistant CARC coatings contain injurious compounds. The best method of removal is to use wet abrasive blasting.
- Do not spray paints or other fluids without proper respiratory protection.
- Do not attempt to spray CARC coatings without using an air-line respirator and full protective equipment (gloves, safety goggles, etc).
- Do not weld or flame-cut CARC-coated metals without first removing the paint.
- Do not grind or sand CARC coatings without full protective equipment, including a high-purity respirator system.
- Do not spray inflammable fluids in the presence of a naked flame.
- Tyres should not be removed using a tyre machine, but by properly dismantling the two-part wheel rim.
- Care should be taken that the tyre is completely deflated, and the valve core should be removed, before splitting the two parts of the rim. If any air is heard to escape as the rim is dismantled, wait until the sound stops and check that the valve stem is not blocked.
- Tyres should always be inflated in a safety cage.

Potential hazards

- Never run the engine in a closed space: brain damage or death can result from heavy exposure to exhaust fumes.
- Diesel fuel, and the fumes produced when the fuel is burned, are believed to be carcinogenic.
- Do not reuse a tyre that has been run flat, even with a run-flat insert, without thoroughly inspecting the carcass for damage.
- Battery acid is corrosive to metal and will burn skin and clothing. Make sure it stays inside the battery!
- The gases produced by an open-vented battery during charging and discharging are highly inflammable and can easily ignite.
- Be careful of short-circuiting the batteries. There is sufficient current available from the 24V circuit to cause the battery casing to split, to start a fire in the wiring or to cause serious skin burns.
- Do not allow any fuels, oils or greases to come into contact with the skin; old engine oil, particularly, contains carcinogenic compounds. Wear disposable gloves or use a good skin barrier cream.
- Be careful not to accidentally put the automatic transmission into gear with the engine running.
- Dispose of used fluids in a responsible manner. Most local authority waste disposal sites have disposal facilities for old oils.

Alternators

- The alternator should be disconnected before undertaking any form of electric welding or cutting (arc, MIG, TIG, plasma cutting, etc).
- Likewise be careful of damaging delicate electronic components by short-circuiting.
- Do not charge the battery without isolating the alternator.

Integrated logistics system

During the development of the Humvee, considerable attention was paid to the question of the logistics of servicing and maintenance. Factors that were singled out for attention included the interchangeability of Humvee parts with those already in the system, as well as the ability to swap parts from left to right, from front to rear and from corner to corner. The requirements for special tools were also considered at each level of maintenance responsibility, as was the question of training.

Get hold of the proper military user manual, the maintenance manual and the parts list relating to your selected model; these are readily available in PDF form, either on CD or as downloads from the Internet. These manuals will repay you time and again in reducing frustration and wasted effort.

Diagnostic facilities

An STE/ICE-R ('simplified test equipment, internal combustion engine, reprogrammable') diagnostic connector provides an attachment point for a vehicle test meter, to facilitate the diagnosis of vehicle electrical and engine systems faults. The corresponding analyser, which is also suitable for the M151, CUCV and 2.5-, 5- and 10-ton 'M series' trucks, carries NATO stock number NSN 4910-01-222-6589.

ABOVE Breakdowns during convoy operation are a fact of life. If the problem is not sufficiently serious to bring the vehicle to an immediate halt, then repairs can be conducted when the convoy halts for a break. Here, US Marine Corps Gunnery Sergeant Sean McDonough makes repairs to a Humvee gun-mount ring. *(US Department of Defense)*

BELOW Of course, workshop facilities make life considerably easier for the vehicle mechanic, and the photograph shows marines from Maintenance Platoon, Headquarters Battery, 1st Battalion, 12th Marine Regiment, Task Force Military Police, working on a disabled Humvee at the 1/12 TFMP motor pool in Al Asad, Iraq. *(US Department of Defense)*

It is possible to find surplus diagnostic units for sale online, but be prepared to pay approaching $500... which is considerably less than the $7,250 these units reputedly cost Uncle Sam!

The transmission indicator lamp, which is illuminated when the ignition switch is turned on, is used to flash diagnostic trouble codes when the transmission control module is placed in the diagnostic mode.

Tools and fasteners

As regards the standard tools required for day-to-day maintenance, get hold of a good selection of Imperial and metric 'AF' ('across flats') spanners and sockets, as well as a range of crowfoot wrenches and Torx and 'hex' driver sockets. Many threaded fastenings are made into aluminium, which makes the use of a torque wrench mandatory. You will also need a lever-operated grease gun, and other standard hand tools such as pliers, feeler gauges, screwdrivers and hammers, etc.

A number of special tools are described in the official documentation, for example for installing seals, adjusting the valve clearances and checking electrical equipment. Specialised equipment, generally beyond the scope of the home mechanic, is required for servicing and repairing the fuel-injection equipment.

Threaded fastenings on the Humvee are a mix of Imperial and metric, using either American NF (SAE National 'fine') or NC (SAE National 'coarse') thread forms – more usually rendered as UNF and UNC – or ISO standard metric threads. It is always good practice to use new fasteners when reassembling parts after maintenance or replacement. However, pay particular attention that any replacements are made on a like-for-like basis as regards tensile strength, or wherever the manufacturer's documentation suggests that special fasteners are required, for example some of the bolts used on the suspension.

Jacking and vehicle support

The vehicle jack, which is of a scissors design with a 2-ton or 3.5-ton capacity, according to variant, is stowed under the engine cover and is held in place by two wing nuts. When removing a wheel the jack should be positioned directly under the lower control arm, next to

the wheel being replaced, and centred squarely under the point of contact. A hydraulic jack can also be used to raise and lower the vehicle. To raise either the front or rear of the vehicle, the jack should be centred under the relevant suspension cross-member, placing a wooden block between the jack and the cross-member. To prevent possible damage the jack should not be placed at any other location, particularly not under the chassis rails.

Should it be necessary to remove the engine for maintenance or repair, it can be supported on a conventional wheeled stand. If either the transmission or the transfer case needs to be removed for repair, a special transmission jack should be used. Trestles, placed under the chassis, can be used to support the body to bring the vehicle to a convenient working height.

Do not work under a vehicle that is supported only by a jack.

Lubrication

The US Army lubrication order (LO 9-2320-280-12) divides routine maintenance tasks into those intended to be carried out by the operator or crew (generally daily, weekly and monthly checks), and those carried out by organisational maintenance staff. The documentation states that '[service] intervals may be shortened if your lubricants are contaminated or if you are operating the equipment under adverse conditions' and that 'intervals may be extended during periods of low activity'.

Technical manual TM 9-2320-280-10 also contains a long list of checks that should be carried out regularly to ensure that the vehicle remains in a 'mission ready' condition. Although most are no more than common sense there is little in the list – with the possible exception of checks on the NBC equipment – that is not equally applicable to a vehicle that is only rarely used, and which is never subjected to the types of abuse that might be experienced in Afghanistan or Iraq.

Servicing schedule

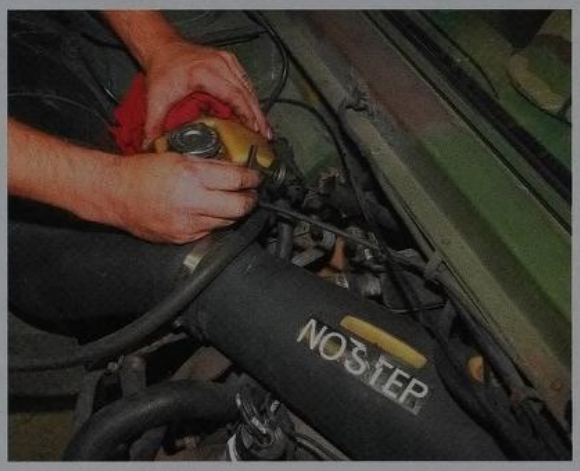
The standard servicing schedule is set out below; man-hour requirements are 0.1 hours for daily checks, 0.2 hours for tasks carried out weekly, and 0.4 hours for monthly checks. Note that the shock-absorber bushings, radius-rod bushings, stabiliser bar bushings and suspension arm pivots should not be lubricated.

Daily: total time, 0.1 man-hours

- Check the engine oil level and replenish as necessary.

LEFT Vehicle mechanics carrying out routine maintenance in preparation for a convoy – Camp Fallujah, Iraq, April 2007. *(Lance Corporal Ashley S. Hoffman; US Department of Defense)*

RIGHT Checking the engine oil.
(Jim Alexander)



RIGHT Checking the transmission oil.
(Jim Alexander)

RIGHT Topping up the cooling system via the radiator surge tank.
(Jim Alexander)

RIGHT Fitting a new air-cleaner element.
(Jim Alexander)

Weekly: total time, 0.2 man-hours

- Daily checks.
- Check the transmission oil level and replenish as necessary; checks should be made with the transmission hot and the engine idling.

Monthly: total time, 0.4 man-hours

- Daily and weekly checks.
- Check the brake fluid reservoir level and replenish as necessary.
- Check the power-steering reservoir level and replenish as necessary; note that both 'hot' and 'cold' oil levels are marked on the indicator.

Every 3,000 miles (5,000km) or every six months: total time, 1.5 man-hours

- Drain and refill the engine oil.
- Change the engine oil filter.
- Check the transfer case oil level and replenish as necessary.
- Check the front and rear differential oil levels and replenish as necessary.
- Check the front and rear hub oil level and replenish as necessary.
- Lubricate the Pitman arm, the intermediate steering shaft, the idler arm and the tie rod ends using medium grease.
- Lubricate the front and rear upper control arm ball joints using medium grease.
- Lubricate the rear radius rod using medium grease.
- Lubricate the front and rear propeller shaft universal joints and the splined coupling using medium grease.
- Lubricate the rear towing pintle using medium grease.
- Lubricate engine cover, door and tailgate hinges, door handles, transmission and transfer shift linkage, accelerator linkage, heater-control shut-off valve, heater control knob and cargo shell lock and latches using light oil from an oil can.

Every 6,000 miles (10,000km) or 12 months: total time, 2 man-hours

- 3,000-mile tasks.
- Drain the fuel filter bowl and replace the filter element; check the water separator and replace if unserviceable.

Every 12,000 miles (20,000km) or every 24 months: total time, 3 man-hours

- 6,000-mile tasks.
- Drain and refill the transmission and transfer case.

Troubleshooting

Useful information for troubleshooting the Humvee is contained in several of the US Army technical manuals. TM 9-2320-280-10, for example, includes a detailed table covering possible problems with starting and operating the engine, malfunctions in the transmission, failure of the charging or electrical system, problems with the brakes, steering system, wheels and tyres, etc.

It is good advice to always check the easiest and most obvious things first. For example, excessive oil consumption is as likely to be caused by leaky gaskets or loose line connections as it is by mechanical problems or wear, whilst excessive fuel consumption could be caused by the fuel pump, by a clogged air cleaner or a restricted exhaust passage causing severe back pressure.

When disassembling the engine in search of a problem, be careful that evidence of what is causing the problem is not destroyed.

TABLE 6: CAPACITIES

Engine	Drain and refill only, 0.875 US gallons (0.725 Imperial gallons; 6.6 litres)
	Including filter change, 1 US gallon (0.83 Imperial gallons; 3.8 litres)
	Including oil cooler, 1.25 US gallons (1.04 Imperial gallons; 9.5 litres)
Radiator and cooling system	3.25 US gallons (2.7 Imperial gallons; 12.25 litres)
Transmission	Drain and refill only, 1.5 US gallons (1.25 Imperial gallons; 5.7 litres)
	Total capacity, 1.75 US gallons (1.45 Imperial gallons; 10.4 litres)
Transfer case	0.875 US gallons (0.75 Imperial gallons; 3.3 litres)
Geared hubs	1 US pint (0.83 Imperial pints; 0.47 litres) each
Front and rear differentials	0.5 US gallons (0.4 Imperial gallons; 1.9 litres) each
Steering system	0.25 US gallons (0.20 Imperial gallons; 0.95 litres)
	Total capacity with steering cooler, 0.375 US gallons (0.3 Imperial gallons; 1.18 litres)
Braking system	Master cylinder only, 0.69 US pints (0.57 Imperial pints; 0.33 litres)
	Total brake system, 1.2 US pints (1 Imperial pint; 0.56 litres)

TABLE 7: ORIGINAL OIL GRADES

Engine	15W-40 multigrade (military designation MIL-L-2104, OE/HDO 15/40), at temperatures above 5°F (-15°C); other oil grades specified for use in extreme temperatures
Transmission	Dexron II (3L80 transmission) or Dexron III (4L80-E) automatic transmission fluid (ATF)
Transfer case	Dexron II automatic transmission fluid (ATF)
Geared hubs	Multi-purpose gear oil (military designation MIL-L-2105)
Front and rear differentials	Multi-purpose gear oil (military designation MIL-L-2105)
Steering box	Dexron II automatic transmission fluid
Braking system	DOT-5 silicone brake fluid (military designation MIL-B-46176)

LEFT The US Marine Corps 'shop equipment contact maintenance and repair' (SECM) truck is equipped with facilities such as flame-cutting and welding tools, as well as carrying maintenance and repair parts and tools to keep vehicles running without returning to base. *(US Department of Defense)*

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Epilogue

The Humvee has now provided almost 30 years' exceptional military service with the US armed forces, as well as elsewhere across the globe. Although it has generally proved to be an extraordinarily capable vehicle, the difficulties of incorporating armoured protection mean that its days in US front-line service are numbered. Whether this will eventually mean that Humvees become a commonplace sight at the average military vehicle show remains to be seen, but it would be a shame if more enthusiasts were not able to appreciate this splendid machine first-hand.

OPPOSITE **Squinting through the sights of a TOW missile launcher, US Army Specialist Wagner checks out an approaching convoy in Riyahd, Iraq, April 2007. The vehicle is an M1114 with the 'objective gunner protection kit'.** *(US Department of Defense)*

Appendices

Dimensions and weight

TABLE 8: DIMENSIONS AND WEIGHT

All variants share the following dimensions: overall width, 85in (2,159mm) or 91in (2,311mm) (M1100 series reliability-enhanced vehicles); wheelbase, 130in (3,302mm); front and rear track, 72in (1,829mm).

Vehicle	Length	Height		Ground clearance		Weight	
		Overall	*Reducible*	*Under axle*	*Under chassis*	*Kerb weight*	*Gross vehicle weight (GVW)*
Original M998 HMMWV series							
M966	180in (4,572mm)	73in (1,854mm)	71in (1,803mm)	16in (406mm)	24in (610mm)	6,051lb (2,750kg)	8,200lb (3,727kg)
M996*	202in (5,131mm)	86in (2,184mm	77in (1,956mm)	16in (406mm)	24in (610mm)	6,748lb (3,067kg)	8,660lb (3,936kg)
M997	202in (5,131mm)	100in (2,540mm)	100in (2,540mm)	16in (406mm)	24in (610mm)	7,180lb (3,264kg)	9,100lb (4,136kg)
M998	180in (4,572mm)	69in (1,753mm)	55in (1,397mm)	16in (406mm)	24in (610mm)	5,200lb (2,364kg)	7,700lb (3,500kg)
M1025	180in (4,572mm)	73in (1,854mm)	71in (1,803mm)	16in (406mm)	24in 610mm)	5,960lb (2,709kg)	8,200lb (3,727kg)
M1026	185in (4,699mm)	73in (1,854mm)	71in (1,803mm)	16in (406mm)	24in (610mm)	6,807lb (3,094kg)	8,200lb (3,727kg)
M1035	180in (4,572mm)	69in (1,753mm)	55in (1,397mm)	16in (406mm)	24in (610mm)	5,297lb (2,408kg)	7,700lb (3,500kg)
M1036	185in (4,699mm)	73in (1,854mm)	71in (1,803mm)	16in (406mm)	24in (610mm)	6,178lb (2,808kg)	8,200lb (3,727kg)
M1037	180in (4,572mm)	69in (1,753mm)	55in (1,397mm)	16in (406mm)	24in (610mm)	5,425lb (2,466kg)	8,660lb (3,936kg)
M1038	185in (4,699mm)	69in (1,753mm)	55in (1,397mm)	16in (406mm)	24in (610mm)	5,327lb (2,421kg)	7,700lb (3,500kg)
M1042	185in (4,699mm)	69in (1,753mm)	55in (1,397mm)	16in (406mm)	24in (610mm)	5,551lb (2,523kg)	8,660lb (3,936kg)
M1043	180in (4,572mm)	73in (1,854mm)	71in (1,803mm)	16in (406mm)	24in (610mm)	6,411lb (2,914kg)	8,400lb (3,818kg)
M1044	185in (4,699mm)	73in (1,854mm)	71in (1,803mm)	16in (406mm)	24in (610mm)	6,538lb (2,972kg)	8,400lb (3,818kg)
M1045	180in (4,572mm)	73in (1,854mm)	71in (1,803mm)	16in (406mm)	24in (610mm)	6,438lb (2,926kg)	8,400lb (3,818kg)
M1046	185in (4,699mm)	73in (1,854mm)	71in (1,803mm)	16in (406mm)	24in (610mm)	6,565lb (2,984kg)	8,400lb (3,818kg)
M1069	185in (4,699mm)	73in (1,854mm)	n/a	16in (406mm)	24in (610mm)	n/a	n/a
M1097 heavy HMMWV variant (HHV)							
M1097	180in (4,572mm)	69in (1,753mm)	55in (1,397mm)	16in (406mm)	24in (610mm)	5,600lb (2,545kg)	10,000lb (4,545kg)
M1097A1	180in (4,572mm)	69in (1,753mm)	55in (1,397mm)	16in (406mm)	24in (610mm)	5,600lb (2,545kg)	10,000lb (4,545kg)
M998A1 HMMWV series, based on M1097 and M1097A1 chassis							
M966A1	180in (4,572mm)	73in (1,854mm)	71in (1,803mm)	16in (406mm)	24in (610mm)	6,928lb (3,149kg)	8,380lb (3,809kg)
M996A1*	202in (5,131mm)	86in (2,184mm)	77in (1,956mm)	16in (406mm)	24in (610mm)	6,928lb (3,149kg)	8,840lb (4,018kg)
M997A1	202in (5,131mm)	102in (2,591mm)	102in (2,591mm)	16in (406mm)	24in (610mm)	7,360lb (3,345kg)	9,280lb (4,218kg)
M998A1	180in (4,572mm)	69in (1,753mm)	55in (1,397mm)	16in (406mm)	24in (610mm)	5,380lb (2,445kg)	7,880lb (3,582kg)
M1025A1	180in (4,572mm)	73in (1,854mm)	71in (1,803mm)	16in (406mm)	24in (610mm)	6,140lb (2,791kg)	8,380lb (3,809kg)
M1026A1	185in (4,699mm)	73in (1,854mm)	71in (1,803mm)	16in (406mm)	24in (610mm)	6,267lb (2,849kg)	8,380lb (3,809kg)
M1035A1	180in (4,572mm)	69in (1,753mm)	55in (1,397mm)	16in (406mm)	24in (610mm)	5,477lb (2,490kg)	7,880lb (3,582kg)
M1038A1	185in (4,699mm)	69in (1,753mm)	55in (1,397mm)	16in (406mm)	24in (610mm)	5,507lb (2,503kg)	n/a
M1043A1	180in (4,572mm)	73in (1,854mm)	71in (1,803mm)	16in (406mm)	24in (610mm)	6,591lb (2,996kg)	8,580lb (3,900kg)
M1044A1	185in (4,699mm)	73in (1,854mm)	71in (1,803mm)	16in (406mm)	24in (610mm)	6,718lb (3,054kg)	8,580lb (3,900kg)
M1045A1	180in (4,572mm)	73in (1,854mm)	71in (1,803mm)	16in (406mm)	24in (610mm)	6,618lb (3,008kg)	8,580lb (3,900kg)
M1046A1	185in (4,699mm)	73in (1,854mm)	71in (1,803mm)	16in (406mm)	24in (610mm)	6,745lb (3,066kg)	8,580lb (3,900kg)

Vehicle	Length	Height		Ground clearance		Weight	
		Overall	*Reducible*	*Under axle*	*Under chassis*	*Kerb weight*	*Gross vehicle weight (GVW)*
M998A2 series							
M997A2	204.5in (5,194mm)	102in (2,591mm)	102in (2,591mm)	17in (432mm)	24in (610mm)	7,660lb (3,482kg)	9,280lb (4,218kg)
M1025A2	190.5in (4,839mm)	73in (1,854mm)	71in (1,803mm)	17in (432mm)	24in (610mm)	6,780lb (3,082kg)	10,300lb (4,682kg)
M1035A2	190.5in (4,839mm)	69in (1,753mm)	55in (1,397mm)	17in (432mm)	24in (610mm)	6,100lb (2,773kg)	10,300lb (4,682kg)
M1043A2	190.5in (4,839mm)	73in (1,854mm)	71in (1,803mm)	17in (432mm)	24in (610mm)	7,230lb (3,286kg)	10,300lb (4,682kg)
M1045A2	190.5in (4,839mm)	73in (1,854mm)	71in (1,803mm)	17in (432mm)	24in (610mm)	7,258lb (3,299kg)	10,300lb (4,682kg)
M1097A2	190.5in (4,839mm)	69in (1,753mm)	55in (1,397mm)	17in (432mm)	24in (610mm)	5,900lb (2,682kg)	10,300lb (4,682kg)
M1109	196.5in (4,991mm)	76in (1,930mm)	n/a	17in (432mm)	24in (610mm)	9,800lb (4,455kg)	12,100lb (5,500kg)
M1121	182.5in (4,636mm)	73in (1,854mm)	71in (1,803mm)	17in (432mm)	24in (610mm)	n/a	n/a
M1123	182.5in (4,636mm)	73.5in (1,867mm)	56in (1,422mm)	17in (432mm)	24in (610mm)	5,850lb (2,659kg)	10,300lb (4,682kg)
M1124	182.5in (4,636mm)	73in (1,854mm)	71in (1,803mm)	17in (432mm)	24in (610mm)	n/a	n/a
Expanded capability vehicles (ECV), based on M1097A2 chassis							
M1113	196.5in (4,991mm)	76in (1,930mm)	56in (1,422mm)	17in (432mm)	24in (610mm)	6,400lb (2,909kg)	11,500lb (5,227kg)
M1114	196.5in (4,991mm)	76in (1,930mm)	72in (1,829mm)	17in (432mm)	24in (610mm)	9,800lb (4,455kg)	12,100lb (5,500kg)
M1115	196.5in (4,991mm)	76in (1,930mm)	n/a	17in (432mm)	24in (610mm)	9,800lb (4,455kg)	12,100lb (5,500kg)
M1116	196.5in (4,991mm)	76in (1,930mm)	72in (1,829mm)	17in (432mm)	24in (610mm)	9,800lb (4,455kg)	12,100lb (5,500kg)
M1145	196.5in (4,991mm)	n/a	n/a	17in (432mm)	24in (610mm)	n/a	n/a
M1100 series reliability-enhanced vehicles, based on M1113 chassis							
M1151	194in (4,928mm)	79in (2,007mm)	n/a	17in (432mm)	24in (610mm)	7,360lb (3,345kg)	13,500lb (6,136kg)
M1151A1**	194in (4,928mm)	80in (2,032mm)	n/a	17in (432mm)	24in (610mm)	8,280lb (3,764kg)	13,500lb (6,136kg)
M1152	194in (4,928mm)	79in (2,007mm)	n/a	18in (457mm)	24in (610mm)	6,530lb (2,968kg)	13,500lb (6,136kg)
M1152A1**	194in (4,928mm)	76in (1,930mm)	n/a	18in (457mm)	24in (610mm)	7,230lb (3,286kg)	13,500lb (6,136kg)
M1165	194in (4,928mm)	75in (1,905mm)	n/a	18in (457mm)	24in (610mm)	6,680lb (3,036kg)	13,500lb (6,136kg)
M1165A1**	194in (4,928mm)	76.25in (1,937mm)	n/a	18in (457mm)	24in (610mm)	7,360lb (3,345kg)	13,500lb (5,500kg)
M1167	194in (4,928mm)	102in (2,591mm)	n/a	16in (406mm)	24in (610mm)	11,250lb (5,114kg)	13,500lb (5,955kg)
M1167A1	194in (4,928mm)	102in (2,591mm)	78in (1,981mm)	16in (406mm)	24in (610mm)	11,250lb (5,114kg)	13,500lb (6,136kg)

* The M996 and M996A1 ambulances were specified, but never actually put into series production.

** Addition of 'B' armour kit increases kerb weight as follows (and, in order to stay within the design gross vehicle weight, reduces payload accordingly): M1151A1 (B1 kit), 2,150lb (977kg); M1152A1 (B2 kit), 1,660lb (754kg); M1165 (B3 kit), 2,640lb (1,200kg).

LEFT Students on the US Air Force Advanced Contingency Skills Training Course 07-2C participate in training for convoy operations on a range at Fort Dix, New Jersey; May 2007. *(US Department of Defense)*

Automotive performance

TABLE 9: AUTOMOTIVE PERFORMANCE

	M998 series	M1097 HHV	M998A1 series	M998A2 series	ECV (M1097A2)	M1100 series
Maximum speed:						
Transfer case in high ratio	70mph (113kph)	70mph (113kph)	70mph (113kph)	70mph (113kph)	70mph (113kph)	70mph (113kph)
Transfer case in low ratio	27mph (44kph)	27mph (44kph)	27mph (44kph)	27mph (44kph)	27mph (44kph)	27mph (44kph)
Acceleration:						
0–30mph (0–48kph)	8 sec	8 sec	8 sec	9 sec	9 sec	9 sec
0–50mph (0–80kph)	n/a	n/a	n/a	26 sec	26 sec	26 sec
0–60mph (0–97kph)	24 sec	24 sec	24 sec	n/a	n/a	n/a
Fuel tank capacity	25 US gal (20.7 Imp gal; 95 litres)	25 US gal (20.7 Imp gal; 95 litres)	25 US gal (20.7 Imp gal; 95 litres)	25 US gal (20.7 Imp gal; 95 litres)	25 US gal (20.7 Imp gal; 95 litres)	25 US gal (20.7 Imp gal; 95 litres)
Fuel consumption (US galls)	12mpg (5.1km/ltr)	12mpg (5.1km/ltr)	12mpg (5.1km/ltr)	11mpg (4.7km/ltr)	11mpg (4.7km/ltr)	9.4mpg (4km/ltr)
Cruising range	300 miles (483km)	300 miles (483km)	300 miles (483km)	275 miles (445km)	275 miles (445km)	235 miles (380km)
Turning circle	49ft (14.84m)	50ft (15.25m)	50ft (15.25m)	50ft (15.25m)	50ft (15.25m)	50ft (15.25m)
Approach angle*	72°, 47°	72°, 47°	72°, 47°	54°, 45°	54°, 45°	46°
Departure angle**	45°, 33.5°	45°	45°	45°	38°	33°
Maximum gradient	60%	60%	60%	60%	40%	40%
Maximum side slope***	40%	40%	40%	40%	30%	40%
Vertical step	22in (559mm)	22in (559mm)	22in (559mm)	22in (559mm)	22in (559mm)	22in (559mm)
Ramp break-over angle	31.5°	31.5°	31.5°	31.5°	31.5°	31.5°
Maximum towed load	3,400lb (1,542kg)	4,200lb (1,909kg)	3,400lb (1,542kg)	4,200lb (1,909kg)	4,200lb (1,909kg)	4,500lb (2,041kg)
Maximum fording depth:						
Unprepared	30in (762mm)	30in (762mm)	30in (762mm)	30in (762mm)	30in (762mm)	30in (762mm)
Prepared	60in (1,524mm)	60in (1,524mm)	60in (1,524mm	60in (1,524mm)	60in (1,524mm)	60in (1,524mm)

* Where two approach-angle figures are quoted, they cover vehicles with and without winch, respectively.

** Where two departure-angle figures are quoted, the second figure refers to vehicles fitted with airlift rear bumper.

*** Maximum side-slope for shelter-equipped variants is 30 per cent.

RIGHT With fuel consumption in the order of 9.4–12mpg (4–5.1km/litre), there is no denying that the Humvee is a thirsty beast. The 25 US gallon (20.7 Imperial gallon, 95 litre) tank gives a range of 235–300 miles (380–483km)... and for most owners a private fuel supply would be most welcome! *(US Department of Defense)*

Military census (registration) numbers

Although all Humvees in US military service are assigned a unique registration number – sometimes described as the 'USA number' – the practice of applying this number prominently to the outside of the vehicle, as was previously the case, has generally been discontinued.

US Army technical manual TB 43-0209 (1990) states that 'there is no further requirement to mark vehicles and equipment with the identification legend "US Army"', and that when vehicles (and equipment) are camouflaged both the 'US Army' and the registration number 'will be removed from vehicle/equipment exterior... the preferred location of the registration number is any appropriate interior area which is visible from outside a locked or secured item.'

The US Marine Corps continues to mark the registration number on the tailgate, prefixed with the letters 'USMC'.

ABOVE Only the Marine Corps vehicles carry an external registration number. *(David Doyle)*

Chassis numbers

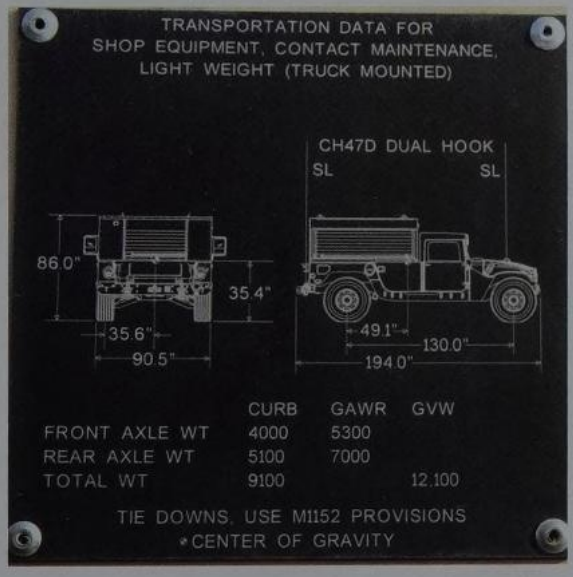
The manufacturer's serial number (VIN number) appears on the military data plate attached to the lower face of the hoop that connects the 'B' pillars on either side of the vehicle. Many of these plates contain incomplete data, and there are also spaces for the US Army registration number, the contract number under which the vehicle was supplied, and the date of delivery.

As you would expect, civilian Humvees have the standard international 17-digit VIN number that indicates country of origin, manufacturer, year, vehicle and engine type, plant, etc, but for the military vehicles the number consists of a simple numeric series, sometimes prefixed 'HUMV', at least in paperwork. This form of number may not be acceptable for civilian registration in some jurisdictions.

Other identifying plates, giving outline dimensions and shipping data, etc, are sometimes fitted to the outside face of the left-hand body side panel, at the rear.

TO ADJUST SEAT
Grasp top and front rails of seat firmly at center and lift into desired position
TRUCK, UTILITY: CGO/TRP CARR
1-1/4 TON, 4X4, W/E, (HMMWV)
M1038
19207-2750052
MFR'S. SERIAL NUMBER
REGISTRATION NUMBER
NATIONAL STOCK NUMBER - 2320-01-107-7156
VEHICLE CURB WEIGHT - 5327 LBS.
PAYLOAD MAXIMUM - 2373 LBS.
GROSS WEIGHT MAXIMUM - 7700 LBS.
DATE OF DELIVERY
CONTRACT NUMBER
U.S. PROPERTY

LEFT Identifying data plates are fitted inside the left-hand door opening, giving details such as the contract number, registration number and date of delivery. This plate identifies the vehicle as an M1038. *(David Doyle)*



LEFT A separate data plate gives transportation and dimensional information, in this case for the 'shop equipment contact maintenance and repair' (SECM) truck. *(David Doyle)*

Parts availability

Most parts seem to be available, although it is usually necessary to shop around, and – given the price of complete vehicles – they are, surprisingly, not prohibitively expensive. A quick search on the Internet shows that, at the time of writing (summer 2013), rebuilt 6.5-litre turbocharged engines are available at around $6,500, a rebuilt transmission can be found for less than $2,000 and the transfer case for a similar sum.

Of course, items such as lighting equipment, switchgear and instruments, particularly on original M998 family variants, are common to other US military vehicles of the period, and the earlier 6.2- and 6.5-litre naturally aspirated versions of the GM V8 diesel engine are a modification of the power unit used in the Chevrolet C/K and M1008/M1009 family of pickup trucks, which might simplify the search for parts.

Military documentation

As you might expect, the military documentation covering the Humvee is both comprehensive and lengthy, and AM General also provides training manuals as part of the integrated logistics support system.

The following list of US Army manuals is by no means comprehensive, but does include those documents which will be most useful to the private owner:

Truck utility, 1-1/4 ton, 4x4. M998, M998A1, M1038, M1038A1, M1097A1, M1097A2, M966, M966A1

- Direct and general support maintenance, including depot maintenance repair parts and special tools lists. TM 9-2920-225-34P.
- Direct support and general support maintenance. TM 9-2320-280-34.
- Hand receipt covering components of end item code, basic issue items. TM 9-2320-280-10-HR.
- Hand receipt covering components of end item code, basic issue items. TM 9-2320-387-10-HR.
- Lubrication order, preventive maintenance service. LO 9-2320-280-12.
- Nomenclature. MWO 9-2320-280-35-1.
- Operator, unit, direct support, and general support maintenance, including repair parts and special tools lists. TM 9-2330-390-14-P.
- Operators manual. TM 9-2320-280-10.
- Operators manual. TM 9-2320-387-10.
- Training program. TC 21-305-4.
- Unit maintenance; volumes 1–3. TM 9-2320-280-20-1, TM 9-2320-280-20-2, TM 9-2320-280-20-3.
- Unit, direct support and general support maintenance, including repair parts and special tools lists; volumes 1 and 2. TM 9-2320-280-24P-1, TM 9-2320-280-24P-2.

Engine, diesel, 8 cylinder, naturally aspirated, fuel-injected, water cooled. DDA model 6.2 litre; DDA model 6.5 litre

- Direct and general support maintenance, including repair parts and special tools lists. TM 9-2815-237-34P.
- Direct and general support maintenance for generator assembly. TM 9-2920-225-34.
- Direct support and general support maintenance. TM 9-2815-237-34.

Other documents

- Radio installation procedures. Truck, utility, cargo/troop carrier, 1-1/4 ton, 4x4. TB 11-2300-478-30-I.
- Color, marking, and camouflage painting of military vehicles, construction equipment and materials handling equipment. TB 43-0209.
- Equipment data sheets for TACOM combat and tactical equipment. TM 43-0001-31.

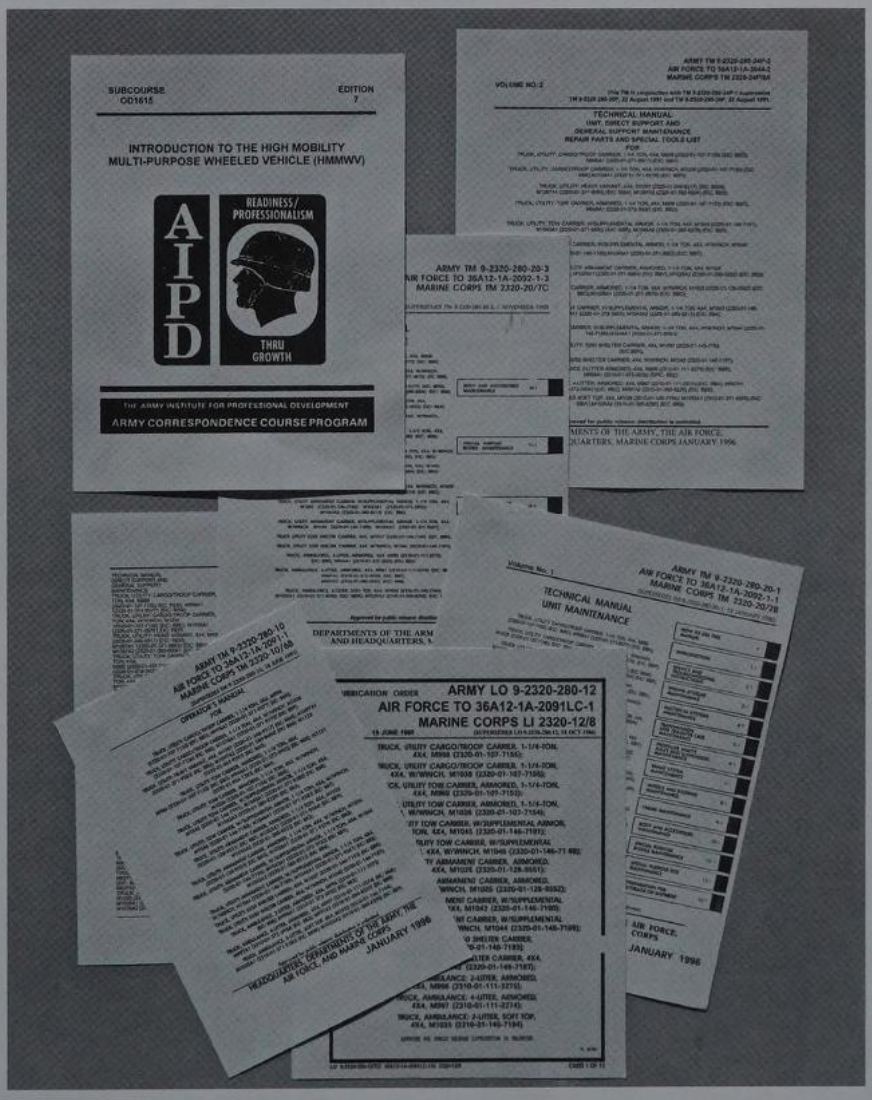
Copies of these manuals are readily available in PDF form on compact disc; visit Military Media Inc at www.militarymanuals.com.

LEFT A collection of AM General's sales material provides a quick overview of the development of the vehicle and the marketing ploys adopted by the company. *(Warehouse Collection)*

Service history

You will be extremely fortunate to discover any details of the service career of any specific Humvee. In theory, the service records for all US Army military vehicles are destroyed once the vehicle is declared as surplus, although if the vehicle has come straight from a US military museum then the records may still exist, since the vehicle remained the property of Uncle Sam until disposed of.

And to make things worse, the lack of visible 'USA' numbers on the vehicle itself means that there is no chance of spotting 'your' vehicle in an official photograph.



RIGHT The official military documentation covering the Humvee is both comprehensive and lengthy, with most of the documents readily available in PDF form on compact disc from Military Media Inc (www.militarymanuals.com). *(Warehouse Collection)*

Useful contacts

You might imagine that the Humvee is a little too modern to be considered a museum exhibit... but you'd be wrong. There are prototypes on display at the Studebaker National Museum and Archives (www.studebakermuseum.org) at South Bend, Indiana; the Veterans Memorial Museum (www.memorialmuseum.org), Huntsville, Alabama; and the Heartland Museum of Military Vehicles (www.heartlandmuseum.com) at Lexington, Nebraska. Production Humvees are also exhibited at the Seabee Museum and Memorial Park (www.seabeesmuseum.com) at North Kingstown, Rhode Island; at the National Navy UDT-Seal Museum (www.navysealmuseum.com) at Fort Pierce, Florida; and at the Marine Corps Mechanized Museum (www.themech.org), Camp Pendleton, California. At the time of writing (summer 2013), the last-named museum is closed temporarily for structural repairs.

Elsewhere, the Military Museum at Belgrade (www.muzej.mod.gov.rs) has a Humvee that was captured from the US Army during 'Operation Allied Force' in 1999, and the Hollywood-based Los Angeles Fire Department (LAFD) Museum (www.lafdmuseum.org) has an unusual and rare civilian fire-fighting variant.

Internet

The best website for Humvee-related information is either The Hummer Network (www.humvee.net) or Hummer Marketplace (www.hummermarketplace.com), both of which provide a forum for owners and enthusiasts and also include vehicles and parts for sale. It is also worth checking out Milweb (www.milweb.net) and Steel Soldiers (www.steelsoldiers.com), both of which include classified ads. Although broader based, the Historic Military Vehicle Forum (www.hmvf.co.uk) may also cover Humvee-related topics.

Military vehicle dealers and sources for parts

Although Humvees rarely come up for sale, a lot of new old stock (NOS) parts do seem to be available – check out www.militaryhumveeforsale.com and www.govliquidation.com. The following companies may be able to provide some assistance, either with vehicles for sale or with parts or restoration services, and of course, it is always worthwhile keeping an eye on eBay (www.ebay.com), using the search term 'Humvee' or 'HMMWV' under the category 'all of eBay motors':

France

Lys Tout Terrain
32 Route de Clarques
Therouanne 62129
Tel (+33) 03 21 38 57 01
Website www.lys-tout-terrain.com

Germany

Army Shop M201
Im Derrück 12
Neuburg am Rhein
76776
Tel (+9) 01727 662498
Website www.us-army-military-shop.de

USA

Alfa Heaven Inc
4381 Stradale Lane, Aniwa, Wisconsin 54408
Tel (+1) 715 449 2141
Website www.alfaheaven.com

AM General Parts
420 S Byrkit Street, Mishawaka
Indiana 46544-3012
Tel (+1) 800 638 8303
Website http://genuinehumveekit.com

Army Surplus Warehouse
635 W Broadway Street, Idaho Falls, Idaho 83402
Tel (+1) 208 529 4753
Website www.armysurpluswarehouse.com

LEFT An M1025A2 TOW missile/ armament carrier, with basic armour, provides the lead vehicle for a short convoy of US Air Force students training at Fort Dix, New Jersey. Next in line is a sand-painted, winch-equipped M1114 up-armoured Humvee (UAH) with a gunner shield kit. *(US Department of Defense)*

Eastern Surplus & Equipment Company
5825 Tacony Street, Philadelphia
Pennsylvania 19135
Tel (+1) 855 332 0500
Website www.easternsurplus.net

The Hummer Experience
Tel (+1) 705 726 7399
Website www.thehummerexperience.com

Hummer Parts Guy
2909 Green Hill Court, Suite B
Oshkosh
Wisconsin 54904 9770
Tel (+1) 920 216 6898
Website www.hummerpartsguy.com

Humvee Shop
8939 S Sepulveda Boulevard
Los Angeles
California 90045
Tel (+1) 714 620 9275
Website www.humvee-shop.com

Idaho Motor Pool
6243 Highway 95
Fruitland
Idaho 83619
Tel (+1) 208 452 5335
Website www.idahomotorpool.com

ISO Group
7700 Technology Drive
West Melbourne
Florida 32904
Tel (+1) 877 330 1580
Website www.isogroup.com

Kascar Real 4WD
One Kascar Plaza
Greenville
South Carolina 29605-6307
Tel (+1) 864 422 0370
Website www.real4wd.com

Mac Motors
635 Louis Drive
Warminster
Pennsylvania 18974
Tel (+1) 215 657 8800
Website www.macmotors.com

Midwest Jeep Willys
24 W 740 Argyle Avenue
Roselle
Illinois 60172
Tel (+1) 630 529 2116
Website www.midwestjeepwillys.com

Military Surplus Vehicles of Dallas
6697 Dallas Acworth Highway
Dallas
Georgia 30132
Tel (+1) 770 443 2805

My Humvee
Website www.myhumvee.com

Rubber Duck 4x4
1622 Smith Road
Hamilton
Ohio 45013
Tel (+1) 513 889 1735
Website www.rubberduck4x4.com

SAX Express
1975 Rabbit Branch Road
Cropwell
Alabama 35054
Tel (+1) 205 863 0314
Website www.sax-express.com

Tech Supply & Services
1531 Pitkin Road
Leesville
Louisiana 71446
Tel (+1) 337 537 7278
Website www.stock-number.com

TNJ Murray Worldwide Service
PO Box 214
Dover
Delaware 19901
Tel (+1) 302 736 1790
Website www.tnjmurray.com

Vintage Military Vehicles
Tel (+1) 970 217 3859
Website http://vintagemilitaryvehicles.com

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AM GENERAL HUMVEE

1985 onwards (all military variants)

In the 30 years since it first appeared, the Humvee has become one of the world's most recognisable military vehicles. This versatile and extremely capable machine has accompanied the US Army on operations in Afghanistan, Africa, the Middle East, and the former Yugoslavia. In addition Humvees are in service with more than 50 other nations.

Development of what was described as the 'high-mobility multi-purpose wheeled vehicle' (HMMWV) started in 1979, when 61 manufacturers were approached with an outline specification. AM General was one of just three companies that submitted production proposals, and was awarded a manufacturing contract in March 1983. The first example of what became known as the Humvee rolled off the production line in January 1984, forming part of an initial range of 16 variants. The powerful V8 engine and innovative driveline provided an extraordinary level of off-road performance, combined with the ability to reach high speeds on hard surfaces.

Although never envisaged as an armoured fighting vehicle there were factory variants described as having either 'basic armour' or 'supplemental armour', but, when faced with the roadside bombs that were commonplace in Iraq and Afghanistan, the Humvee's shortcomings became apparent. So began a cycle of up-armouring. More armour meant more weight, and more weight put additional strain on the chassis and drivetrain, which eventually sounded the death knell for the vehicle. In 2011, the US government announced that the Humvee would be replaced by the all-new joint light tactical vehicle (JLTV). Humvee production, at least for the US Army, ended with more than 281,000 examples constructed.

This book describes the Humvee in detail, covering the story of its development, setting the vehicle into its historical and military context, and describing key features. For would-be owners, the book also addresses the problems of finding, restoring and operating a Humvee, and looks at the thorny question of price.

Pat Ware has been a full-time motoring writer for the past 18 years, with more than 35 books to his name. Specialising in commercial and military-vehicle subjects, he has been a regular contributor to magazines such as *Classic Military Vehicle*, *Classic Commercial Vehicle*, and *Supply Line* for more than a decade. This is his sixth title for Haynes, with earlier subjects including the Jeep, Sherman tank, and military Land Rover.

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